ACCS XI

Abstracts Booklet

DAY 1 – FRIDAY, DEC 13, 2024

8:00–9:30	*Registration*	
9:30–10:00	*Opening Ceremony*	
10:00–11.00	**Keynote 1: RAJESH RAO** **Chair: Narayanan Srinivasan**	**ACTIVE PREDICTIVE CODING AND THE PRIMACY OF ACTIONS IN PERCEPTION AND COGNITION**
11:00–12:00	*Coffee Break + Poster Session 1*	
12:00–1:00	**Talk Session 1: Actions** **Chair: Devpriya Kumar**	1. *The recalibration of hand position estimates following sensory mismatch by Sahu, Ajay Kumar*; Mutha, Pratik (IITGn)* 2. *Prioritizing Task-Relevant Motor Corrections in Bimanual Coordination through Flexible Feedback Control by Ravikumar, Preethi*; Sahu, Ajay Kumar; Mutha, Pratik (IITGn)* 3. *Interaction between Implicit and Explicit Processes in Motor Adaptation by Kumar, Adith Deva*; Kumar, Adarsh; Kumar, Neeraj (IIT Hyderabad)*
1:00–2:00	*Lunch*	
2:00–3:00	**Talk Session 2: Emotion & Cognition** **Chair: Pratik Mutha**	1. *Creation of Indian Child Affective Face and Gaze database by Tiwari, Ganga*; Patel, Shailendra; Velamur Vasudevan, Amruthavalli; Rastogi Kar, Bhoomika (CBCS, U. of Allahabad)* 2. *Co-joint impact of aversive information and reward motivation on task-relevant stimulus processing by Jaiswal, Sagarika*; Chakravarthy, Lakshman; Padmala, Srikanth (IISc)* 3. *Influence of structure and trait-anxiety on patch foraging behaviour by Vatsa, Shruti*; Ramakrishnan, Arjun (IIT Kanpur)*
3:00–4:00	**Keynote 2: KRANTI SARAN** **Chair: Surampudi Bapi Raju**	**ATTENTION WITHOUT THE WILL– RETHINKING THE DISTINCTION BETWEEN TOP-DOWN AND BOTTOM-UP ATTENTION**
4:00–5:00	*Coffee Break + Poster Session 2*	
5:00–6:00	**Talk Session 3: Language** **Chair: Pushpak Bhattacharyya**	1. *How DLM Interacts with Accessibility in Modulating Word-Order during Sentence Production in SOV Languages by Zafar, Mudafia*; Husain, Samar (IIT Delhi)* 2. *Investigating the Effect of Orthographic Transparency on Phonological Awareness in Bilingual Children with Developmental Dyslexia: An ERP Evidence by Raveendran, Sruthi*; C. Shanbal, Jayashree; Kim, Jooyoung (IITGn)* 3. *ShabdGyaan: A pilot study precursor to mega-study on word recognition, individual differences and vocabulary size estimation by Singh, Ansh ; Agrawal, Niket*; Verma, Ark*
6.00–6:30	*Sponsor's Session*	*Parag S. Amodkar, Tiden Technologies*

DAY 2 – SATURDAY, DEC 14, 2024

9:00–10:00	**Front desk open**	
10:00–11.00	**Talk Session 4: Memory** **Chair: Sumitash Jana**	1. *Role of Contextual Cues on the Expression of Competing Motor Memories by Kumar, Adarsh (Queen's Univ); Kumar, Adith Deva*; Kumar, Neeraj (IIt Hyderabad)* 2. *Effect of Value-Based Decision on Intentional Cognitive Offloading for Prospective Memory by Agarwal, Aashna*; Bennett, Cathlyn Niranjana (Christ Univ); Chandran, Vladimir (Univ of Arts)* 3. *Manipulating Boundary Conditions: Prediction Error and Memory Strength to Initiate Memory Reconsolidation by Paul, Tripureshwari*; Asthana, Manish Kumar (IIT Roorkee)*
11:00–12:00	*Coffee Break + Poster Session 3*	
12:00–1:00	**Keynote 3: SUPARNA RAJARAM** **Chair: Bhoomika Kar**	**SOCIAL REMEMBERING–A COGNITIVE PERSPECTIVE**
1:00–2:00	*Lunch*	
2:00–3:00	**Talk Session 5: Learning & Memory** **Chair: Azizuddin Khan**	1. *Interlimb Differences in Implicit and Explicit Learning Processes in Visuomotor Adaptation by Vaasanthi, Sinchana*; Mutha, Pratik (IITGn)* 2. *Contextual expression of motor adaptation does not update the existing motor memories by Jain, Riddhi*; Kumar, Neeraj (IIT Hyderabad)* 3. *Role of Working Memory in Interlimb Generalization of a Newly Learned Motor Skill by Pal, Rahul*; Yadav, Goldy (Université Catholique de Louvain); Matkar, Shraddha ; Kumar, Neeraj (IIT Hyderabad)*
3:00–4:00	**Keynote 4: MANEESH SAHANI** **Chair:** **Krishna P. Miyapuram**	**NOISE, UNCERTAINTY, PRIORS AND BIAS IN PERCEPTION**
4:00–5:00	*Coffee Break + Poster Session 4*	
5:00–6:00	**Talk Session 6: Perception and Action** **Chair:** **Pragathi Balasubramani**	1. *Do you see an object to use it or to hold it: role of structural and functional actions in object processing by Padia, Tanvi*; Kumar, Devpriya (IIT Kanpur)* 2. *Negligible Allocentric Representation Benefits in Contextual Cueing Effects by Mishra, Ananya*; Thomas, Tony (IIT Roorkee)* 3. *Investigating perceptual boundaries of Self-Prioritization effect in Abstract Shape Paradigm using Priming effect by Singh, Neetu *; Ahmad, Irfan; Verma, Ark (IIT Kanpur)*
6.00–6:30	*GBM*	
7:30–9:30	*Conference Dinner – VMCC Ground Floor Foyer and Cafeteria Area*	

DAY 3 – SUNDAY, DECEMBER 15, 2024

9:00–10:00	**Front desk open**	
10:00–11.00	**Talk Session 7: Cognitive Control /Decision Making/Actions** **Chair: Srikanth Padmala**	1. *Hand dominance does not influence EEG-EMG coherence during grasping by Balasubramanian, Eswari; Balsubramanian, Sivakumar; SKM, Varadhan* (IIT Madras)* 2. *Attribute trade-off difficulty modulates the asymmetric-dominance of the decoy by Rath, Tapas*; Srivastava, Nisheeth; Srinivasan, Narayanan (IIT Kanpur)* 3. *'Sounds like a skill issue': what makes you quit at chess? by Purohit, Hariharan; Srivastava, Nisheeth* (IIT Kanpur)*
11:00–12:00	*5 Coffee Break + Poster Session 5*	
12:00–1:00	**Keynote 5: CHANTAL SOELCH** **Chair: Ramesh Kumar Mishra**	**THE REWARD SYSTEM AS AN INTERFACE BETWEEN MOTIVATION, PLEASURE AND COGNITION**
1:00–2:00	*Lunch*	
2:00 – 2:40	**Talk Session 8: Cognition and Applications** **Chair: Rashmi Gupta**	1. *Exploring the Role of Cognitive Empathy in Shaping Universalism-Based Human Values: A Gender-Driven Analysis by Mannu Brahmi (IIT Delhi); Riya Jain ; Alma Ali* (Indraprastha College for Women, DU); Shreya Sarkar (Savitribai Phule Pune University); Jyoti Kumar (IIT Delhi)* 2. *Quality of Sleep, Stress and Academic performance among University Students during Covid-19 pandemic by Matrapu, Praneetha Teja* (IITGn); Gadiraju, Padmaja (UoHyd)*
2:45–3:30	**Talk Session 9: Emotion & Cognition** **Chair: Ark Verma**	1. *Emotion Can Fool Your Perception but Not Action: Differential Effect of Emotion on Perception vs Action Task by Sahai, Ananyaa*; Singh, Divita (Ahmedabad Univ); Kumar, Neeraj (IIT Hyderabad)* 2. *Emotions in Spatial Representation: Interaction of Valence and Arousal in Route and Survey Knowledge by Donni, Sacheth Kiran* (Christ Univ); Basu, Sandhya (Azim Premji); Rangaswamy, Madhavi (Christ Univ)*
3:30-3:45	**Vote of Thanks!**	

POSTER SESSION 1/DEC 13-AM

No	Title	Author
1.	*Memory of Emotional Events Under Cognitive Load Influence Resting State Functional Brain Connectivity in Subclinical Anxiety*	*Shruti Kinger*
2.	*Effect of Mind Wandering and Framing on Risky Decision-Making: An Experimental Investigation*	*Saba Siddiqi*
3.	*Perception of experience influences altruism and perception of agency influences trust in human-machine interactions*	*Balaraju Battu*
4.	*A Novel BCI Classifier for Classification of Multi-Class Motor Imagery Data*	*Parth G. Dangi*
5.	*Brain gut coupling can predict the severity of levodopa induced dyskinesia in Parkinson's Disease*	*Sanket S. Houde*
6.	*Resilience of temporal order judgment to early-onset, prolonged visual deprivation*	*Naviya Lall*
7.	*Prosocial skill development in adolescents through video game interleaved with an online course: An Intervention study*	*Arvindhane M.*
8.	*Spectral Analysis of Novice Reflective States: The Role of Gamma and Delta Power on Performance During Breath-Focused Meditation*	*Mannu Brahmi*
9.	*The Costs of Action-Effect Monitoring*	*Inchara Manjunatha Atharv Nangare*
10.	*Exploring the Impact of Monetary Value on Retrieval-Induced Forgetting*	*Kevin Prince*
11.	*Myelin Plasticity in the Visual System Following Extended Visual Deprivation*	*Chetan Ralekar*
12.	*Exploring the role of conceptual mappings in attentional engagement during metaphor processing*	*Sumeet Agarwal*
13.	*Understanding the Navigation Network System- An fMRI investigation*	*Swati Khandual*
14.	*Navigating the Memory Maze: Cognitive Avoidance Effects on Autobiographical Memory in Healthy and Depressed Minds*	*Anoushka*
15.	*The differential effects of performance contingent and non-contingent rewards on emotional distraction*	*Athulya Krishnan*
16.	*Facilitating Moral Transformation through Reflection among Young Adults*	*Drishti Bhatia*

POSTER SESSION 2/DEC 13-PM

No	Title	Author
1.	*Exploring the Relationship of Fear of Happiness between Anxiety, Social Isolation, and Decision Making: Mixed Method Study"*	*Chakshu V. Jain*
2.	*The Role of Visual Working Memory Capacity in Autobiographical Memory Bias among Individuals with Social Anxiety Disorder*	*Sherine G. Victoria*
3.	*Effect of Environmental Value Orientation Framing on Pro-Environmental Behaviour Intentions Using Motivated Attention Framework: An Eye-Tracking Study*	*Madhumitha K.*
4.	*Attribution, JTC Reasoning and Social Threat Perception in Individuals with Paranoid Ideations and the Mediating Role of Interoceptive Sensitivity*	*Tripti Singh*
5.	*Exploring Ethical Decision-Making in Driving Dilemmas: A Mixed*	*Pragati Gohil*

	Methods Study	
6.	*Annotation of Silent Pauses in Emotional Narratives under Gesture Restrictions*	*Riya Jain*
7.	*Mapping the Circumplexity of Personality Metatraits, Schwartz's Values, and Trait Mindfulness in Indian Adults: A Principal Component Analysis Approach*	*Mannu Brahmi*
8.	*Investigating Neural Activity in a Recurrent Network: Insights from Simulating a Go/No-Go Task*	*Rakesh Sengupta*
9.	*Parenting now and then: An Intergenerational Analysis of Perceived Parenting in Young Adults and Middle Age Adults*	*Nihala Abdul Samed*
10.	*Exploring human defense responses in a 3D virtual reality environment: An EEG study*	*Vidisha Maithani*
11.	*Effect of inhibitory control training on extinction of conditioned fear*	*Kaneez F. Dar*
12.	~~*Visual perception during neurotypical development and in Autism and ADHD*~~	~~*Georgitta J. Valiyamattam*~~
13.	*Evaluating smartphone notifications as an ecologically valid conditioned stimulus for studying emotion-evoked neural responses*	*Prakash Mishra*
14.	*Facial Emotion processing in Early Alzheimer's Disease, Mild Cognitive Impairment & Healthy Individuals*	*Rajesh PG*
15.	*Replication and Validation of Trait Anxiety EEG Biomarkers Utilizing Stop-Signal Task*	*Pragya Verma*
16.	*Free-choice intentions but not instruction-based action planning influences subsequent executive control*	*Niteesh Deep Sharma*

POSTER SESSION 3/DEC 14-AM

No	Title	Author
1.	*Testing the impact of Reduced Mind Wandering on Response Inhibition*	*Menka Singh*
2.	*Differential effects of arm and finger posture on Tactile Enumeration*	*Ashutosh Bagchi*
3.	*The Effect of Word Order in Modulating Visual Attention During Spatial Language Comprehension*	*Kanika Sachdeva*
4.	*Hindi-Urdu Causative Event Structure Acquisition*	*Parul Bhardwaj*
5.	*Understanding the Temporal oddball effect: Investigating the role of repetition suppression and Anticipation.*	*Amrendra Singh*
6.	*The Impact of Metacognitive Awareness and Cognitive Flexibility on Pattern Recognition Task Performance*	*Jaanvin Jaanvin*
7.	*Gaze and Gluttony: How Weight Shapes Our Initial Food Fixations*	*Rajashree Biswas*
8.	*Effect of Induced Empathy on Decoy Effect in Consumer Decision-Making Task*	*Yashika Garg*
9.	*Exploring the Relationship Between Switch Cost, Functional Connectivity and Task Complexity in a Task Switching Paradigm using EEG*	*Gargi Shukla*
10.	*Varied interlocutors' language proficiency alters cross-linguistic activation in bilinguals: Evidence from eye movements.*	*Keerthana Kapiley*
11.	*"Efficacy of Regulation Focused Psychotherapy in Managing Externalizing Behavioural Problems among Children and Adolescents - a Psychophysiological Study"*	*Payal Sipani*
12.	*Role of Loneliness on Attentional Bias and Social Working*	*Niharika Gopalakrishna*

	Memory in Young Adults	
13.	*Investigating Hippocampal Long Axis Specialization with High-Resolution 7T fMRI*	*Atharv D. Nangare*
14.	*Late sight-onset and its influence on visual search*	*Manvi Jain*
15.	*Reconstruction of Drumbeat Music from EEG Data*	*Pradipto Pradipto*
16.	*Lack of Haptic-Sound Symbolism in Congenital and Late Blind Population.*	*Srisai Rakesh Kottu*

POSTER SESSION 4/DEC 14-PM

No	Title	Author
1.	*The Effect of Depressive Symptoms, Post-Traumatic Growth, and BRCA Gene Mutation on Attentional Bias Towards Body Image and Acceptance of Femininity among Breast Cancer Patients*	*Anika Duttagupta*
2.	*The Impact of Socioeconomic Disadvantage and Parental Alcohol Abuse on Children's Executive Functions in Urban India: A Pilot Study*	*Aditi Varenya*
3.	*Studying the Role of Gamma oscillations in Motor Control using a bio-inspired Actor-Critic based Oscillatory Neural Network*	*Vigneswaran C*
4.	*The Sunshine Effect: The Impact of Vitamin D Deficiency on Physical and Mental Health*	*Sameeksha Satheesh*
5.	*Spatial Location Encoding of Auditory Sources in the Human Brain: An EEG Study*	*Aditi Jha*
6.	*Perceptual load influences gradedness of awareness of gist in visual scenes in a dual task: Gist perception is more graded in high load*	*Suraj Kumar*
7.	*The Impact of Allocentric Shifts in the Emotional Regulation of Autobiographical Memory Recall*	*Pinky Arya*
8.	*Does Temporal attention influence Perceived Time and Temporal Sensitivity?*	*Utkarsh Shukla*
9.	*Influence of Semantic Binding on visual search: Interplay of Long-Term and Working Memory*	*Antarjot Kaur*
10.	*Heterogeneity in Loss Aversion Estimates across Modelling Approaches*	*Akhil Abburu*
11.	*Exploring Cognitive and Psychological Changes through Auditory Mantras in an Immersive Virtual Reality (VR) Environment*	*Dhrubajyoti Sarma*
12.	*Human-Robot Interaction in Economic Decision-Making: Insights from Dictator Games*	*Avantika Dev*
13.	*The Cognitive Toll of Household Air Pollution: Cross-sectional Associations between Polluting Cooking Fuel Use, Cognitive Functions and Brain MRI in a Rural Indian Aging Population*	*Sumedha Mitra*
14.	*Neural Entrainment to Consonant and Dissonant Musical Stimuli: An EEG Study*	*Aditi Jha*
15.	*Effect of Contemplative Debate Practice (from Gelug Tradition) on Emotion Regulation and Experience*	*Sudhakar Mishra*
16.	*The Hindi Lexicon Project: Lexical decision data for 11500 Hindi words*	*Vivek S Sikarwar*
17.	*Exploring Functional Neurological Overlaps in Adults with ADHD and Schizophrenia: An fMRI Study Using Deep Learning Model.*	*Fatima Sanwari*
18.	*Effect of Individualized taVNS on Motor Cortical Excitability: A Paired-Pulse TMS Study*	*Nisma Fathima*

POSTER SESSION 5/DEC 15-AM

No	Title	Author
1.	*Emotions and Driving: Effect of Emotions on Speed During Sudden Pedestrian Crossing Event*	*Debaparna Mukherjee*
2.	*Exploring User Engagement on Dating Apps: An Eye-Tracking Study*	*Fatima Sanwari* , Pragati Gohil, Madhavi Rangaswamy, Shuchita Gupta*
3.	*Biopsychosocial Factors Affecting Illusion of Transparency*	*Praneetha Teja Matrapu*
4.	*Task Irrelevant Self-Relevant Primes Engage Attention*	*Adithi Anil*
5.	*The impact of mental fatigue on the working memory capacity and executive functions of young adults*	*Prerna Dash*
6.	*The Effect of an Episodic Future Thinking Strategy on The Prospective Memory of People with PCOS*	*Tarisha Badaya*
7.	*Models, Modalities, and Features: Classification of Affective Music Video Clips and Participants from Neural Signals*	*Jhanvi Mehta*
8.	*The Dichotomy of Bias Behaviour: Inhibition of Automaticity in Ingroup Bias for Deliberative Decisions*	*Abhishek Baba*
9.	*Self-prioritization modulates the multiple object tracking performance*	*Irfan Ahmad*
10.	*Comparing visual scene salience representations in deep neural networks and the human brain*	*Shreya Gakhar*
11.	*Learned Helplessness suppresses Action Bias and not Pavlovian Bias*	*Adithya Anil*
12.	*Cultural dependency and inter-subject variability for emotion recognition from EEG signals*	*Aditi Jha*
13.	*LLMs and Ethical Dilemmas: Would AI push you off a boat to save five people?*	*Akhil Abburu*
14.	*Cultural Leaders: Transforming Cooperative Norms Beyond Self-Interest*	*Balaraju Battu*
15.	*High Schizotypy is Associated with Greater Susceptibility to Tactile illusions and Intact Vibrotactile Perception*	*Sreelakshmi K.*
16.	*Exploring the Relationship between Anxiety, Cognitive Function, and Heart Rate Variability in Young Adults*	*Hurshitha Vasudevan*

Table of Contents

Keynote Abstracts

Oral Presentations

Posters

KEYNOTE ABSTRACTS

Active Predictive Coding and the Primacy of Actions in Perception and Cognition

Rajesh Rao
https://www.cs.washington.edu/people/faculty/rao

Recent neurobiological experiments indicate that almost all cortical areas, even those traditionally labelled as sensory, are modulated by upcoming actions. Parallel evidence from neuroanatomical studies points to major outputs from neurons across cortical areas to subcortical motor centres. To account for these findings, we propose that the neocortex implements active predictive coding (APC), a form of predictive coding that combines actions and hierarchical sensory-motor dynamics. We provide examples from simulations illustrating how the same APC architecture can solve problems that seem very different from each other: (1) how do we recognize an object and its parts using eye movements? (2) why does perception seem stable despite eye movements? (3) how do we learn compositional representations, e.g., part-whole hierarchies, and nested reference frames? (4) how do we plan actions in a complex domain by composing sequences of sub-goals and simpler actions, and (5) how do we form episodic memories of our sensory-motor experiences and learn abstract concepts such as a family tree? Our results from the APC model illustrate the critical role played by actions, both external and internal to the brain, in mediating perception and cognition.

Attention without the Will: Rethinking the Distinction between Top-down and Bottom-up Attention

Kranti Saran
https://www.ashoka.edu.in/profile/kranti-saran/

It is no accident that St Augustine is credited with two connected ideas of great importance to the history of the top-down/bottom-up distinction. The first is his doctrine of the will, modeled on the divine will, that is constitutively tied to agency, freedom, responsibility, willpower, and is implicated in all action (Dihele 1982). The second is his distinction between voluntary (i.e. willed) and involuntary (i.e. not willed) shifts of attention (Hatfield 1998). Both profoundly shaped what emerged as the top-down/bottom-up distinction. Yet Augustine's ideas are philosophically loaded and far from compulsory. We can do better. Drawing on recent work in philosophy by Ganeri (2018) and in psychology by Benoni (2020, 2018), I critically assess the prospects of four models of the top-down/bottom-up distinction in psychology: the traditional dichotomy (e.g. Baluch & Itti 2011), a trichotomy (Awh et. al. 2012), a revised dichotomy (Egeth 2018), and the relevance spectrum proposal (Benoni 2018). Inspired by early Buddhist thinking on the nature of attention, I propose a reconfiguration of the top-down/bottom-up distinction that dispenses with Augustine's ideas and better fits the empirical data.

Social Remembering: A Cognitive Perspective

Suparna Rajaram
https://www.stonybrook.edu/commcms/psychology/faculty/faculty_profiles/srajaram

Shared stories are the glue of our social lives. As social animals, families, partners, friends, study groups, work teams, and more broadly, communities and societies develop shared representations of their past. These collective memories fulfil a variety of personal, cultural, educational, and political goals, and have long been topics of interest in history, anthropology, sociology, and social psychology. By contrast, cognitive psychological investigation has lagged despite early interests in the social transmission of memory in Bartlett's seminal 1932 treatise. Over a century of scientific experimental research on memory has instead almost exclusively focused on the individual. Leveraging the principles developed in this foundation of experimental research on individual memory ability, my research group investigates social influences on memory. This paradigm shift opens the opportunity to examine how individual memory constraints shape the performance of the group, and in turn, how collaborative remembering by a group reshapes the memory of each member. Our key questions include how memory contagion spreads in groups for both true and false information, how contagion patterns shift in larger groups containing both direct and indirect social connections, and how social transmission of information synchronizes memory across people. I will discuss data and theory from my lab on the cognitive mechanisms that shape how people remember, misremember, forget, and synchronize information by working in groups. This experimental approach has the potential to offer insights into how social transmission of memory influences human thinking, decision-making, behaviour, and a range of socially relevant endeavours.

Noise, Uncertainty, Priors and Bias in Perception

Maneesh Sahani
https://www.gatsby.ucl.ac.uk/~maneesh/

A physically identical stimulus presented over and over may evoke a somewhat different percept on each occasion. Psychophysical models describe this variability as coming from internal processing noise, the scale and influence of which is robustly measurable, but the origin of which is at best incompletely understood. However, although the noise itself appears inescapable, two decades of research has shown that the way noisy sensory signals are processed is often close to optimal. I will review some of these results, highlighting the ways that noise-induced uncertainty shapes perceptual decisions and report. I will end with two recent experiments that probe the treatment of uncertainty about remembered stimuli. These experiments have allowed us to characterise precisely the decision process underlying stimulus reconstruction; and to reveal the way observers rely on "prior" knowledge from recent experience to shape current percepts.

The Reward System as an Interface between Motivation, Pleasure and Cognition

Chantal Martin Soelch
https://www.unifr.ch/psycho/en/department/staff/dept/people/6316/9b1e3

The cerebral reward system groups together a set of brain regions specifically involved in the processing reward information. First identified as the brain's pleasure center, it is now considered a neural correlate of motivation. It involves subcortical regions, such as the striatum and prefrontal cortex, and can be studied in a translational manner. At both cortical and behavioral levels, it can be seen as an interface between motivation, cognitive performance and pleasure. During this conference, behavioral and neuroimaging results from our group will be presented, illustrating this interface role and integrating research on the link between dopamine, pleasure and reward.

ORAL PRESENTATIONS

Talk Session 1: Actions

The recalibration of hand position estimates following sensory mismatch

Sahu, Ajay Kumar*; Mutha, Pratik
IIT Gandhinagar

Introduction

Our brain constantly integrates and processes information from the visual and proprioceptive senses to create a coherent and accurate representation of the body and its surroundings [1]. However, when external factors cause a mismatch between these senses, our brain tries to compensate for this error by updating our motor plans, a process termed motor adaptation. An interesting byproduct of adaptation is sensory recalibration, wherein the estimated position of the limb is altered relative to its actual position [2]. For example, Cressman and Henriques (2009) demonstrated that when subjects adapted to a clockwise visuomotor rotation, their proprioceptive estimates became biased toward the left, in line with the direction of motor adaptation. Similarly, Salomonczyk et al. (2011) found that with prolonged training, an increased visuomotor rotation led to a greater shift in the hand's estimated position in the direction of adaptation [3, 4]. However, these studies did not account for various factors that could influence the recalibration process. More recently, Babu et al. (2023) found that the rate at which these cross-sensory mismatches were induced impacted the magnitude of visual and proprioceptive recalibration [5]. In the current study, we aimed to better understand the dynamics of recalibration. We specifically asked: 1) whether recalibration continues to occur if a mismatch is reintroduced following an initial dissociation of vision and proprioception, and 2) whether and how recalibration is extinguished if the mismatch is eliminated.

Methods

We performed 2 experiments, each with 4 groups of young, healthy, right-handed subjects. Subjects were required to move their right index finger from a single starting position to either a visual (white box displayed on a horizontally mounted screen) or a proprioceptive (unseen index finger of the left hand) target. Three types of trials were employed: 1) visual and proprioceptive (VP) trials, wherein both the visual and proprioceptive targets were present, 2) visual only (V) trials in which only the visual target was shown, and 3) proprioceptive only (P) trials in which only the proprioceptive target was used. In experiment 1, the locations of the visual and proprioceptive targets were initially matched, but subsequently, a dissociation of 50 mm between their positions was induced (phase 1) on the VP trials at different rates for different groups of subjects (one shot: 50 mm in a single trial, fast: 3.34 mm per trial, medium: 1.67 mm per trial, slow: 0.87 mm per trial). Trials were presented in a quartet in the following order: VP, P, VP, V. On VP trials, subjects were told to “move their right index finger to the white box which was on top of their target finger”. On V trials, they were told to “move to the white box” while on the P trials, they were asked to “move to where they thought their target finger was”. Once the 50 mm mismatch was achieved, it was maintained as such until the 120th trial, following which another 50 mm mismatch was introduced (phase 2) at the same rate as before. In Experiment 2, a 50 mm dissociation was first introduced (phase 1) in the exact same manner as Experiment 1, held at this level until the 120th trial, and was then extinguished in phase 2 of the experiment at the

rate at which it was introduced. Our main variable of interest was the final position of the right index finger at the end of the movement.

Results

We observed clear recalibration in response to the mismatch between the visual and proprioceptive target positions. In Experiment 1, participants estimated their left index finger to be further away from its actual position. That is, they estimated it to be closer to the visually displayed target. Further, the amount of recalibration was tightly coupled to the rate at which it was introduced; recalibration was highest for the one-shot and fast groups and lowest for the slow group. Additionally, recalibration levels were maintained as long as the mismatch was maintained. When the additional mismatch was created in phase 2, subjects began recalibrating again, with the final recalibration level once again being sensitive to the rate of mismatch introduction. In Experiment 2, subjects recalibrated during phase 1 in a manner very similar to Experiment 1. Remarkably, in phase 2, when the mismatch was removed, recalibration was also extinguished at a rate that paralleled the rate of mismatch removal. All subjects eventually returned to matched estimates of the visual and proprioceptive targets.

Discussion

Our goal was to better understand the dynamics of sensory recalibration by probing its persistence and extinction following the introduction and elimination of sensory mismatches. Our results indicate that sensory recalibration occurs whenever there is a visuoproprioceptive mismatch and diminishes when the mismatch is removed regardless of whether it is abruptly or gradually introduced. Notably however, the magnitude of recalibration is influenced by the rate at which the mismatch is introduced, although it appears to reach a saturation point as the rate increases. We conclude that recalibration is a highly dynamic process that arises whenever there is a cross-sensory conflict.

References

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2. Rossi, C., Bastian, A. J., & Therrien, A. S. (2021). Mechanisms of proprioceptive realignment in human motor learning. Current Opinion in Physiology, 20, 186-197.
3. Cressman, E. K., & Henriques, D. Y. (2009). Sensory recalibration of hand position following visuomotor adaptation. Journal of Neurophysiology, 102(6), 3505-3518.
4. Salomonczyk, D., Cressman, E. K., & Henriques, D. Y. (2011). Proprioceptive recalibration following prolonged training and increasing distortions in visuomotor adaptation. Neuropsychologia, 49(11), 3053-3062.
5. Babu, R., Lee-Miller, T., Wali, M., & Block, H. J. (2023). Effect of visuoproprioceptive mismatch rate on recalibration in hand perception. Experimental Brain Research, 241(9), 2299-2309.

Prioritizing Task-Relevant Motor Corrections in Bimanual Coordination through Flexible Feedback Control

Ravikumar, Preethi*; Sahu, Ajay Kumar; Mutha, Pratik
IIT Gandhinagar

Introduction

We can perform independent tasks with each arm as well as tasks that require the coordinated use of both arms. Early research on bimanual coordination showed that performing different tasks with each arm often leads to interference, resulting in more symmetrical movement patterns (Franz et al. 1991; Kelso et al., 1979). This led to the hypothesis that upper limb coordination is primarily driven by shared motor commands. However, subsequent studies revealed that bimanual coordination is influenced by task context and goals rather than being solely reliant on spatiotemporal symmetry (Diedrichsen, 2007; Mutha and Sainburg, 2009). Recent work by Kitchen et al. (2023) argued that the control of each arm can be independent or codependent, depending on its contribution to the achievement of task goal. They found that altering each arm's contribution to the perpendicular motion of a shared feedback cursor during forward reaching reduced variability in the arm with a higher contribution while allowing the other arm to vary more, indicating task-dependent modulation. While Kitchen et al. focused on perpendicular motion, other research (Gordon et al., 1994; Krakauer et al., 2000; Fu et al.,
1995) has shown that errors in movement direction and extent are processed differently. Therefore, it is unclear 1) whether such task-dependent modulation of bimanual coordination occurs while correcting to perturbations in movement extent, and 2) whether the sensorimotor system can resolve simultaneously imposed alterations in the perpendicular (errors in movement direction) and parallel directions (errors in extent).

Methods

We employed the bimanual shared cursor task to four groups of healthy, right-handed young adults. A shared cursor, representing the weighted average of both arms' positions, was displayed on a horizontal screen. Participants were instructed to move both arms together to guide the cursor from a starting point to a target in a smooth, straight motion. We altered the shared cursor feedback by changing the gain of each arm's contribution to the cursor's perpendicular (x-coordinate) and/or parallel (y-coordinate) position. In group 1, the contribution of each arm to the cursor's horizontal direction, which is perpendicular to the reaching, was manipulated, while keeping the parallel (vertical) contribution equal. This implies that the right arm had higher contribution to the cursor's horizontal movement, while the left arm had lower contribution and was counterbalanced in the following block. In group 2, we varied each arm's contribution to the parallel motion of the cursor, keeping the perpendicular contribution constant. In group 3, we changed the contributions in the perpendicular and parallel directions simultaneously: one arm contributed more to perpendicular and less to parallel cursor motion, while the other had opposite contributions. In group 4, the same arm contributed more to both perpendicular and parallel cursor motion, while the other arm contributed less to both directions. We determined the perpendicular and parallel deviations for each arm by subtracting the movement end-point from the virtual target's x and y-coordinates, respectively. To examine the changes in coordination pattern under imposed asymmetric gains, we examined the changes in covariation relationship between the perpendicular and parallel deviation of the left and right arm.

Results and Discussion

Replicating Kitchen et al., we first found that if an arm contributed more to the perpendicular motion of the cursor, its variability in that direction was restricted compared to the arm that contributed less. In group 2, when we altered the parallel gain of the cursor, we again found a reduction in variability of the arm with the higher contribution to cursor motion and increased variability in the other, but in the parallel direction. In group 3 and group 4, we found that irrespective of the gain combinations, the arm with the higher perpendicular contribution showed reduced lateral variability and the arm with the higher parallel contribution demonstrated restricted parallel variability, while allowing the corresponding lower contribution arms to compensate for the shared cursor errors.

The findings from this study reinforce the notion that coordination of bilateral movements is not "coupled", rather is highly task-dependent, with the sensorimotor system adapting its control strategies based on the contribution of each arm to the task goal. Our results extend the work of Kitchen et al. (2023) by showing that task-dependent modulation of bimanual coordination is not limited to perturbations in the perpendicular direction but also applies to errors in movement extent. This suggests that the sensorimotor system prioritizes the corrections for deviations directly impacting task goals (higher contribution arm), while tolerating more variability in less relevant dimensions (lower contribution arm). This study extends the understanding of bimanual coordination by showing that task-dependent modulation occurs not only in response to directional errors but also when adjustments in movement extent are required, highlighting the complex and adaptable nature of human motor control.

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Interaction Between Implicit and Explicit Processes in Motor Adaptation

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The primary function of our brain is to coordinate movements. Throughout our lives, we engage in motor learning, which involves practice-dependent changes in motor performance [1]. Motor adaptation is a specific type of motor learning that occurs in response to changes in the environment, leading to adjustments in behavior. Through adaptation, task performance is maintained by either modifying the current motor action or selecting a previously well-practiced one. Traditionally, motor learning was viewed as a single process [2]. However, subsequent research has revealed that multiple distinct mechanisms contribute to overall motor learning which include the slow and fast components [3], which later were found to be associated with implicit and explicit learning processes [4]. Implicit learning is a slow and gradual process characterized by persistent aftereffects [5,6,7]. Explicit motor learning involves re-aiming strategies that explicitly select existing motor plans during motor planning [8]. However, the interactions between these processes in motor learning remain poorly understood.

To explore this, we divided the study into two experiments in which participants (n=64) learned tasks requiring different adaptation mechanisms (implicit or explicit), sequentially in order to investigate the interaction between them. In this study, we used target jumps of varying magnitudes (i.e., small 15° and large 45°) to induce implicit and explicit processes. We assumed that the small target jumps would be learned through implicit processes while the large jumps learned through explicit strategy. Point-to-point reaching tasks were used, where the participants had to adapt to the error introduced by the small and large target jumps during learning.

In experiment 1, we aimed to explore the interaction between implicit and explicit processes when learned sequentially and also aimed to determine whether the underlying mechanism adapts to different task requirements or remains consistent. After a baseline block consisting of no jump trials, participants then completed two sequential learning blocks with either small target jumps followed by large jumps or vice versa. No-feedback blocks were presented consisting of trials with no jump and cursor feedback, to assess the aftereffects of the learning processes. Three sub-blocks of no-feedback trials (early, middle, and late) were interspersed within the learning blocks to measure the aftereffects across learning. Our results revealed that participants who first learned the small target jumps (implicit learning) exhibited aftereffects in the late sub-blocks of the initial learning block as well as in all three sub-blocks of the subsequent learning block with large target jump. This pattern of aftereffects persisted in the no-feedback blocks following both learning phases. In contrast, participants who learned the large jumps (explicit learning) first, did not show any aftereffects in the subsequent learning phases or no-feedback blocks. These findings suggest that the initial learning mechanism influences subsequent learning through a carryover effect.

In experiment 2 we tried to address whether the effects observed in the second learning block were due to anterograde interference from the first motor learning block. The experimental design was similar to Experiment 1, except that no-feedback blocks were presented immediately after the learning blocks to measure aftereffects specific to each learning phase. We hypothesized that the no-feedback block following the first learning block would act as a washout, removing the use-dependent effects from the first block and returning performance to baseline. Findings suggested that the aftereffects observed in the second session were a result of the initial learning mechanism persisting into subsequent stages rather than being influenced by anterograde interference. This is evidenced by the presence of aftereffects in both the no-feedback block when the initial learning involved an implicit mechanism. No

aftereffects were observed in both no-feedback blocks where the initial learning included large jumps, indicating that the observed effects were not merely due to anterograde interference but rather a carryover of the learning mechanism. The aftereffects observed in the sub-blocks were similar to experiment 1.
Overall, the results from these experiments suggest that even when the second learning block required a different adaptation mechanism, the mechanism used in the first learning block appeared to persist. We assume this persistence is likely due to the similarity of the task nature (target jumps) and the absence of contextual changes between learning blocks.

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Talk Session 2: Emotion & Cognition

Creation of Indian Child Affective Face and Gaze database

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Introduction

Decoding emotions from face and social cues from gaze is important for social communication, emotion understanding, prediction of intention. Differences in processing of emotions in terms of recognition of facial expressions, social interaction patterns, display rules for emotions to know or predict one's intentions, and the intensity/arousal of the emotional display, have been found across cultures/ethnicities and age groups. A study on Child Affective Facial Expression (CAFÉ) (Prada et al., 2018) have reported cross-cultural differences in the accuracy for recognition of sad, surprise and neutral expressions but no significant differences between child and adult raters for emotion recognition. However, Vesker et al (2017) have reported more positive ratings by child raters across all emotions. Studies on social-emotional cues including facial expressions with gaze (Liang et.al., 2021) have shown that happy and neutral emotions with direct eye gaze are perceived more intense compared to averted gaze whereas anger and fear with averted gaze reported more intense ratings compared to direct gaze. Given the mixed findings pertaining to the use of peer-age stimuli for facial emotion perception, the current study intended to develop and validate a Child emotional faces -gaze database in Indian context for its wider application in developmental research.

Method

7 face expressions (Happy, angry, fear, disgust, sad, surprise, neutral) with 44 child models (Mean age= 8.5 yr) were created. The facial features for each emotion were mapped on the basis of FACS (facial action coding system) by Ekman & Friesen. Total 145 images were obtained for 7 emotions. Images were clicked using DSLR Nikon 5500, focal length= 95mm, Image dimension= 6016*4016. Images were normalized for brightness, contrast and luminance; reduced to 462*540 pixels using Adobe photoshop. Images were rated on: valence, intensity, genuineness (5-point Likert scale) and depicted emotion (7). Faces were rated by 50 child (mean age: 9.5 years), 30 adults (mean age: 22 years). Also, in the separate ongoing rating study, averted gaze images were created using an online AI editor, HeyPhoto. Left- right gaze in these images were cropped and realigned onto straight-gaze image using facial landmark detection. Image editing done with Python Dlib (2015) and Python PIL. Obtained 140 images are rated for depicted emotion (happy, angry, neutral), gender, gaze.

Results

Overall accuracy was higher for positive emotion recognition in children and lowest for fearful expression. A 2-way ANOVA [2 (Age-group) x 7 (emotion)] was performed for each dimension separately to examine the effect of emotion on ratings. Effect of emotion was significant for all dimensions. Effect of age was significant for intensity & valence ratings. A significant Age*Emotion interaction was found for all three dimensions. Intensity: Bonferroni corrected post-hoc tests for the effect of emotion showed high intensity ratings for anger followed by disgust. Children showed higher intensity ratings for anger compared to sad *(p*=0.002) whereas adults rated angry emotion as more intense than happy (p<.001). Children showed lower intensity ratings for sad emotion than adults *(p*=0.004*)*. Valence:

Overall, angry and disgust expressions were perceived as more negative compared to other emotions and children had more positive ratings across all emotions. Children rated angry, disgust and sad emotions as less negative compared to adults (All *ps*<.05). Genuineness: Overall angry, disgust, happy, and neutral expressions were perceived as more genuine than sad emotion. For adults' angry emotion was perceived as more genuine than fear, sad and surprise (All *ps*<.05), while happy and neutral expressions were perceived as more genuine than sad (All *ps*<.01). Children perceived sad emotion as less genuine than surprise (*p* = .04). A 2-way ANOVAs [3(gaze) x 3 (emotion)] was performed to analyze the effect of depicted emotion and gaze direction three dimensions of intensity, accuracy & certainty. A significant effect of depicted emotion on accuracy (*F* (2,216) = 15.28, *p*<0.001) was found. Post-hoc comparisons showed that for happy as depicted emotion, the mean accuracy was higher when it was anger (M = 19.5, SE =3.8) or neutral (M =.17.3, SE=
3.8).

Discussion

This is the First Indian Child Affective face database which provides a stimulus set validated with child and adult ratings on dimensions of intensity, valence and genuineness for seven emotions. Ratings on all dimensions varied across emotions. The significant age effect and its interaction with emotions substantiates the need for a peer-age stimulus set of facial expressions. The distinction between positive and negative emotions with respect to valence and intensity was less distinct for child raters. Interestingly, adults perceived sad expression as less genuine compared to all other emotions suggesting that children's expression of sadness may not be as differentiable. In addition, accuracy for emotion recognition in the gaze context compared to straight gaze was low in case of child raters and was highest for happy expression.

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Co-joint impact of aversive information and reward motivation on task-relevant stimulus processing

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IISc

Introduction

Motivation and ensuing actions to achieve rewards could be influenced by conditions competing with the reward's motivational value. For instance, graphic warnings on cigarette packets are meant to dampen the motivational value associated with smoking. However, the limited findings so far regarding how aversive information influences reward motivation are mixed[1,2] and its subsequent effect on goal-relevant stimulus processing is unclear. To investigate this, we employed functional MRI (fMRI) in healthy adult human volunteers (N=37; 21 males; age: 22.54 ± 3.76 years) to examine the interactions between aversive emotion and reward motivation and how their combined influence modulates task-relevant stimulus processing.

Method

In each trial (Fig 1A), during the initial *Cue* stage, participants were presented with an emotional image of negative or neutral valence. The valence indicated whether the trial carried a potential to win bonus reward based on performance in the succeeding task. After a jittered delay, an image of a house or building was presented (*Task* stage), and participants were instructed to respond whether they saw a house or a building with designated button presses. They were told that on each reward prospect trial, an accurate *and* fast response (faster than the response time (RT) threshold calculated from calibration run prior to the main experiment) would lead to a reward of Rs. 2. This main experimental task was subdivided into two phases (Fig 1B): in one phase, aversive image signalled reward and neutral indicated no-reward. In the other phase, this emotion-reward mapping was reversed. Overall, it was a 2 *Emotion* (neutral, negative) x 2 *Reward* (no-reward, reward) within-subjects design. A brief training run was included before each phase to ensure participants correctly learned the emotion-reward mapping.

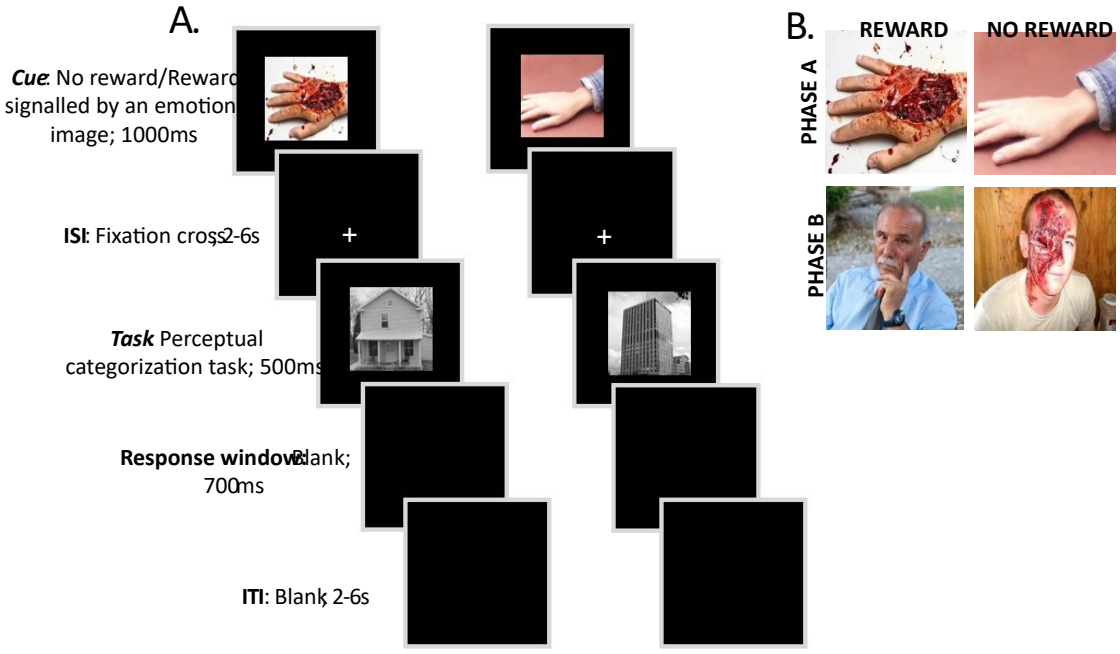

Figure 1: Task paradigm. (A) Trial structure: Each trial started with an emotional image signalling reward or no-reward opportunity (*Cue* stage) for 1000ms. After a jittered ISI, participants performed a perceptual categorization task (*Task* stage), indicating whether the displayed image (500ms) is a building or a house. This was followed by an extended response window for 700ms and an ITI for 2-6sec. (B) Valence of emotional images at the *Cue* stage indicated reward or no-reward opportunity: in phase A, negative signalled reward, and neutral signalled no-reward. This emotion-reward mapping was reversed in Phase B. The order of phase A and B was counterbalanced across participants.

Results

A 2 *Emotion* (neutral, negative) x 2 *Reward* (no-reward, reward) rmANOVA on the RT data yielded a strong main effect of *Reward* ($F_{(1, 36)} = 67.89$; $p < 0.001$), with faster responses during reward compared to no-reward trials. This indicated successful valence evaluation of the emotional images to ascertain whether a reward was at stake or not. However, no main effect of *Emotion* ($F_{(1, 36)} = 0.07$; $p = 0.791$) or *Emotion* x *Reward* interaction ($F_{(1, 36)} = 7.283x10^{-4}$; $p = 0.979$) were detected.

In terms of fMRI data, we conducted ROI analyses in our *a priori* regions of interest (vmPFC, amygdala, and ventral striatum), which were frequently implicated in reward and emotion processing. From these ROIs, we obtained beta estimates corresponding to the four *cue* conditions and ran a 2 *Emotion* x 2 *Reward* rmANOVA to test for potential interactions. We observed a significant main effect of *Emotion* in the amygdala (negative > neutral; $F_{(1, 36)} = 32.48$; $p < 0.001$) and the vmPFC (negative < neutral; $F_{(1, 36)} = 4.913$; $p = 0.033$), and a significant main effect of *Reward* in the ventral striatum (reward > no-reward; $F_{(1, 36)} = 16.73$; $p < 0.001$). Crucially, we did not detect any significant interaction effects, suggesting that aversive emotion and reward expectancy were processed independently, engaging distinct regions during the *Cue* stage.

We next examined how the concurrent emotion and reward at the *Cue* stage impacted subsequent task-relevant stimulus processing in the para-hippocampal gyrus (PHG), a region that strongly responds to images of houses and buildings. Using a focused ROI analysis[3], we conducted a 2 *Emotion* x 2 *Reward* rmANOVA on the *task*-stage beta estimates and observed a significant interaction effect in PHG ($F_{(1, 36)} = 4.68$; $p = 0.037$; Fig 2A). This interaction was primarily driven by the *smaller* difference between reward and no-reward conditions during the negative compared to neutral condition. Furthermore, across participants, the interaction scores in PHG and behavioural RT were significantly inversely correlated ($r(36) = -0.33$, $p= 0.048$; Fig 2B).

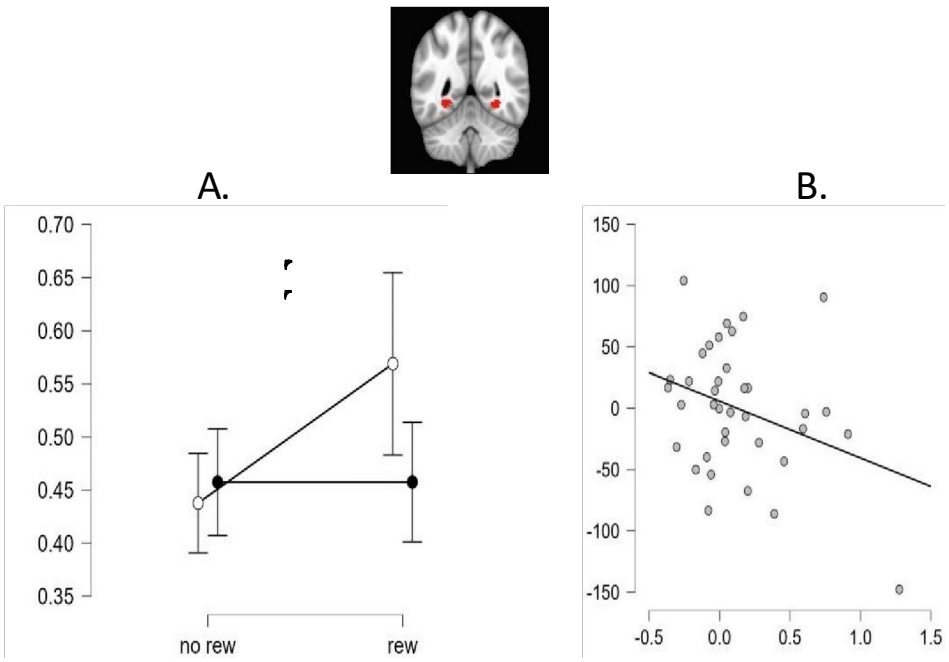

Figure 2: ROI analysis in bilateral para-hippocampal gyrus (PHG). (A) The plot shows the pattern of interaction between *Emotion* and *Reward* in bilateral PHG. (B) Brain behaviour correlation between PHG and RT interaction scores.

Finally, to assess the degree to which sensitivity to emotion and reward processed at the *Cue* stage had a combined influence on the task-related processing, we conducted moderation analysis using a generalized linear regression model as follows:

$$PHG\ interaction\ score = b_0 + b_1 VS\ rew\ main\ eff + b_2\ vmPFC\ emo\ main\ eff + b_3(VS\ rew\ main\ eff\ X\ vmPFC\ emo\ main\ eff)$$

We employed reward and emotion main effects in VS and vmPFC, respectively, and their interaction as the predictors, and PHG interaction effect as the dependent variable. We observed a significant relationship between VS *Reward* main effect x vmPFC *Emotion* main effect interaction and the PHG interaction score (b_3 = -3.24, p = 0.0027). For better understanding, we split the participants into two sub-groups: below (high aversive) and above (low aversive) the median vmPFC emotion main effect score (Fig 3), as an index of aversiveness sensitivity to the emotional images. For the low aversive group, there was no change in PHG interaction with changing reward effect in VS. This implied that perceptual processing in individuals showing low emotion sensitivity was not strongly modulated by emotion. However, for the high aversive group, the strength of competitive-type interaction increased with increasing reward effect in VS; such individuals were more likely to show stronger attenuation in reward-related improvements in perceptual processing.

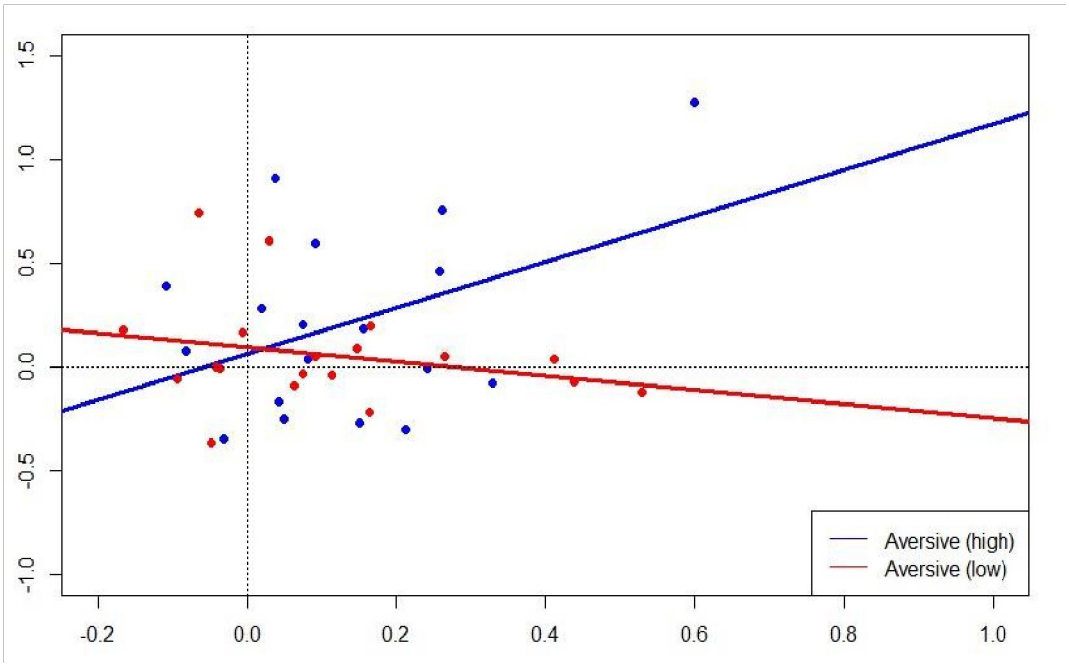

Figure 3: Patterns of relationship between reward effect in VS at the *Cue* with interaction effect in PHG at the *Task* stage in individuals exhibiting low (red) and high (blue) sensitivity to aversive images in vmPFC

Discussion

Our fMRI findings shed light on the conjoint influence of emotion and reward in shaping task-relevant processing. The interaction pattern in PHG indicated that aversive images, compared to neutral, dampened the effects of reward motivation. Interestingly, this interaction effect was correlated with the interaction pattern in behavioural RT, across participants. Finally, moderation analysis revealed how reward cue effects in VS and emotion cue effects in vmPFC interacted to drive the competitive interaction in PHG during the subsequent *Task* stage. Overall, this study provides insight into how conflicting value signals co-jointly shape task-relevant stimulus processing in the human brain, thereby potentially impacting behaviour.

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Influence of structure and trait-anxiety on patch foraging behaviour

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Introduction

During the COVID-19 pandemic, the structure of the environment and its functionalities suffered a massive breakdown leading to higher levels of uncertainty. When the uncertainty regarding the resource availability in the market was at its peak, signalling a changing environment, it led to anxiety-like behaviours in individuals leading to maladaptive foraging, like hoarding of groceries, perishable materials and basic requirement goods[1].

Although structure plays a crucial role in shaping our optimal strategies, typical lab-based patch foraging tasks haven't looked at the effects of the environmental structure. Further, these tasks have utilised Marginal Value Theorem (MVT) as the benchmark for optimal foraging which does not take into account the environmental structure. Although there is some evidence in literature that sequential changes in the environmental conditions do impact foraging[2, 3, 4], to study these in a more systematic way we have come up with a foraging task design where participants are engaged in environments that vary in structure in a systematic or random fashion.

Earlier work has shown that internal states like fatigue, stress, and mental health conditions, like anxiety and depression, impact foraging behaviour[5]. Therefore, we also used self-reported measures of anxiety and depression to address inter-individual differences in behaviour. Overall, we found that participants could take advantage of the order in the environment to optimise their strategies that deviated from MVT based predictions. Further, trait anxious individuals displayed lower stay duration in patches and lower adaptation to the changing environment type – from random to ordered structure.

Methods

Participants

A total of 89 participants (age group: 18 to 35; 22 females, 67 males) from Indian Institute of Technology (IIT) Kanpur were recruited for the experiment. All the participants provided their informed consent and were compensated with a fixed monetary amount for participation and a variable monetary amount based on their performance in the task.

Experimental design

The experiment utilised a virtual patch foraging task under controlled conditions. The task (Figure 1) was divided into two blocks: ordered and random, of 15 minutes each, with an infinite number of patches to harvest (A similar task has been used in Avisha et al., 2023 & Barack et al., 2024). The ordered block had a discrete sinusoidal-like variation of inter-patch travel time (IPTT), with "ascending" and "descending" phases of the IPTTs, taking six values in a definite sequence – 3, 6, 9, 12, 15, 18 and 21. The random block consisted of the possible IPTTs in an unpredictable arrangement with no orderliness present in them. In each trial, participants had to decide whether to harvest the current patch or leave it to move to the next one. For each harvest, rewards were displayed alongside the patch; rewards in a patch decreased with subsequent harvests following the formula $^{\max(0,}$ $7 - 0.5 \times (n - 1) + N(0, 0.25)^{)}$

where n is the number of harvest decisions made so far in the patch, and $N(0, 0.25)$ denotes a Gaussian distribution with mean 0 and standard deviation 0.25.

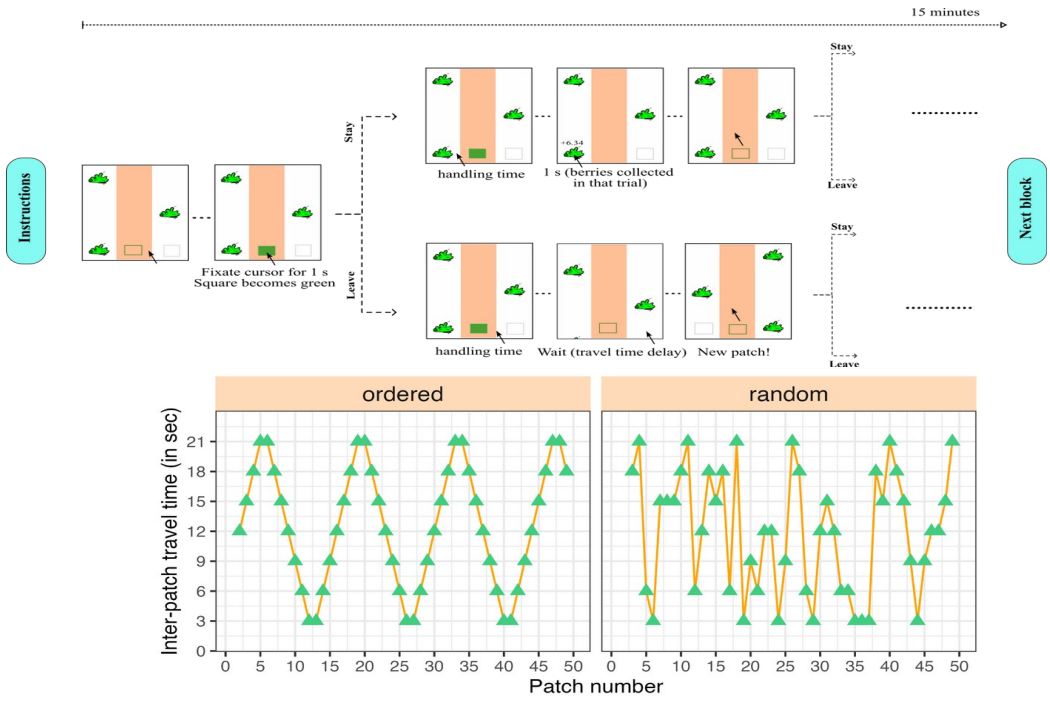

Figure 1: Task design for a trial in a block (top) and inter-patch travel time for the two blocks: random and ordered (bottom).

Self-report questionnaires

Before the experiment, participants answered Generalised Anxiety Disorder (GAD-7), the State-Trait Anxiety Inventory for Adults (STAI form Y-1 and Y-2) and Patient Health Questionnaire (PHQ-9).

Data pre-processing

Out of the 89 participants, we excluded participants based on attention checks and these exclusion criteria: mean TD > (mean TD + 2* SD) of the sample in any one of the two blocks, mean number of harvest decisions fell in the lower 5 percentile values in any one of the two blocks, the ratio ($^{total}number\ ^{number}\ of\ ^{of}patches\ stay\ ^{decisions}\ left\ for\ new\ in\ ^{the}\ ones\ ^{block}$), fell in the lower 5 percentile values in any one of the two blocks, accumulated reward from the task fell in the lower 5 percentile values. Owing to these exclusion criteria, we analysed the data of 78 participants in this study.

Results

We analysed the two blocks, random and ordered, separately because of the difference in the structure of the task design. Along with descriptive analysis, we implemented linear mixed-effects modelling (LMM). We investigated patch-level stay duration (StD), trial-wise reaction time (RT), and patch-level berries collected (BerCol) to understand participant's decision-making in the task. However, here we only describe the inferences made with StD.

1. Do participants behave differently in the two blocks, i.e., ordered and random? We hypothesised the order of IPTT to have a significant effect on foraging behaviour, i.e., participants would forage more efficiently in the ordered block than the random block. Although post-game self-report survey analysis revealed a majority, 60.67%, of the participants to be unsure about noticing an order in the game, an LMM model with block type as a fixed effect and stay duration as the dependent variable confirmed that

the participants adjusted their behaviour by reducing their patch stay duration (β = 0. 08, 95% CI [0. 04, 0. 12], p <. 001) (Figure 2).

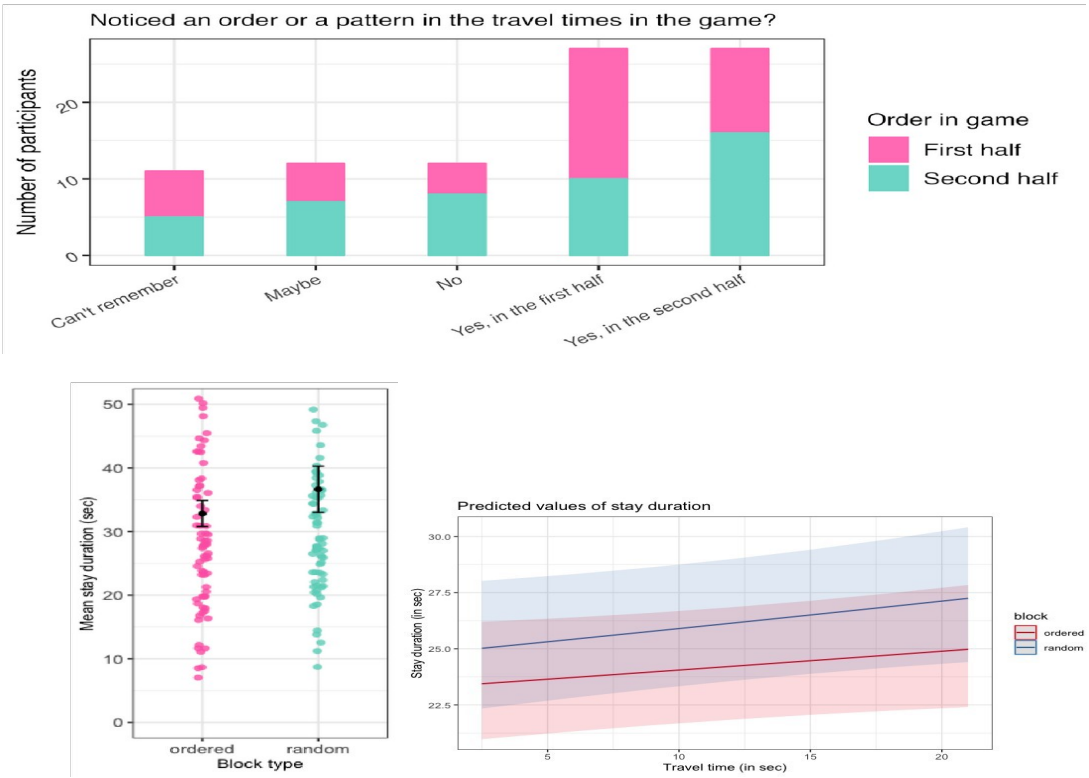

Figure 2: self-report analysis (top), stay duration vs. block type and IPTTs (bottom).

2. a) Are participants sensitive to changes in IPTT?
In the ordered block, IPTT showed a positive and significant effect on patch-level stay durationeffect of (β = IPTT0. 01, 95was% CI[0positive. 00, 0. 01],and p < 0tended. 05).
In towardsthe random significance block, the (β = 0. 005, 95% CI [0. 00, 0. 01], p = 0. 06) (Figure 2(bottom)). Thus, as hypothesised, a higher stay duration in patches with higher inter-patch travel time was observed as predicted by the MVT.
b) Do participants behave similarly in the ascending and descending phase of IPTT of the ordered block?

As hypothesised, the LMM model *(formula: log(StD) ~ IPTT * order + (1 | participant))* estimated a positive and significant effect of order (ascending and descending) (β = 0. 60, 95% CI[0. 14, 1. 05], p < 0. 05) on StD of the participants. Overall, higher StDs were observed in the descending than the ascending phase of IPTTs. Although StD increased with an increase in IPTTs in the ascending phase, an opposite relationship was observed in the descending phase, i.e., high IPTTs led to shorter StDs (Figure 3).

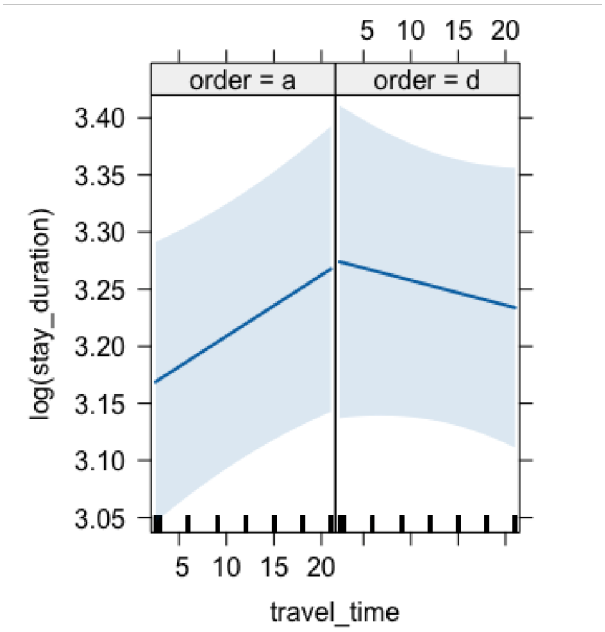

Figure 3: Fitted prediction for log(stay duration) against IPTTs and order in the ordered block.

3. Does trait anxiety impact foraging behaviour?

In the ordered block, interaction between order and trait anxiety (TA) scores showed a negative and significant effect on the StDs ($\beta = -0.01, 95\%\ CI[-0.02, -0.00], p < .05$). It was observed that individuals with high TA (HTA) scores had shorter StDs compared to low TA (LTA) individuals (Figure 4). The effect of order was significantly less for the HTA than the LTA individuals, showing an impoverished adaptation to the changing environment in the HTA individuals. In the random block, there was no significant effect of TA levels on the foraging behaviour.

Depression and anxiety levels gauged through PHQ-9, GAD-7 and STAI-State scores showed no effect on StDs in both the blocks.

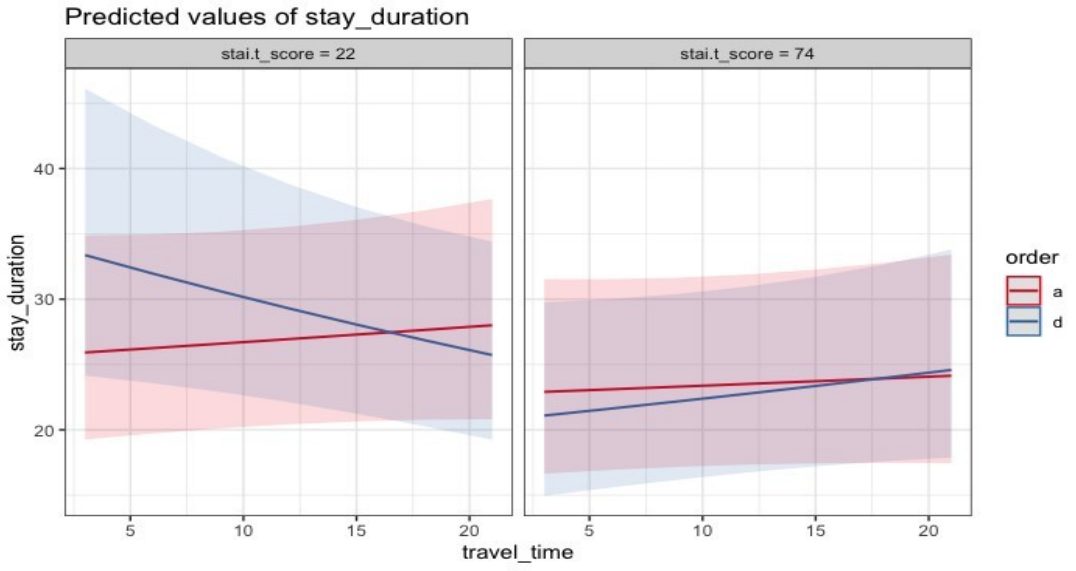

Figure 4: Predicted values of stay duration for both ascending and descending phase of IPTTs as a function of TA scores.

Discussion

Participants responded to order in the environment by reducing their stay duration to optimise their reward collection. They were also differentially sensitive to ascending and descending orders of travel duration. Those with high trait anxiety scores stayed for lesser duration and were less sensitive to changes in order (ascending vs. descending) but collected more berries in the ordered environment. Work is in progress to understand the optimal strategies in such a sequentially changing environment.

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Talk Session 3: Language

How DLM Interacts with Accessibility in Modulating Word-Order during Sentence Production in SOV Languages

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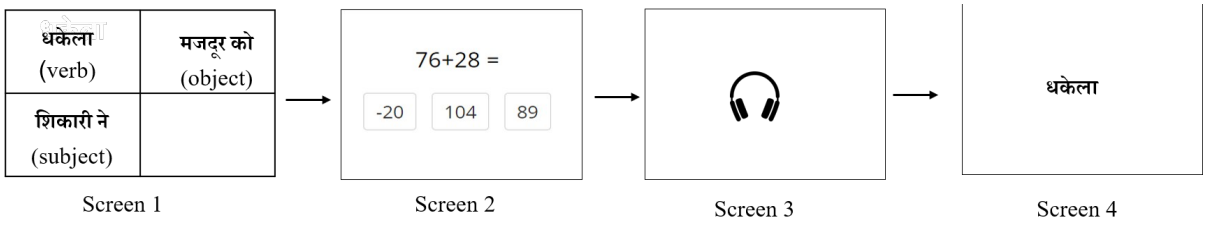
Introduction

Understanding the factors determining word-order during speaking informs us about the scope of planning and the nature of the language production architecture [1]. Dependency-Length Minimization (DLM) [2] and Accessibility [3] have been implicated in determining word order and are assumed to cause shifts from the canonical to the non-canonical word-order during sentence production. Interestingly, the two accounts assume different cognitive mechanisms. According to DLM, word-order variation is a product of keeping syntactically related words proximate to each other to reduce working memory load. Contrarily, according to Accessibility, word-order variation results from differences in ease of lexical access between different elements of a sentence during production. As a consequence, the two accounts also vary with respect to their assumptions about the scope of planning. Accessibility entails incremental/sequential planning, while DLM calls for more non-incremental/structural planning [4]. Thus, it becomes crucial to test independent as well as cumulative effects of the two accounts in shaping word-order. In SVO languages, [5] found that while both DLM and Accessibility influence word-order, Accessibility played a stronger role – the effect of DLM was visible only when Accessibility did not make any predictions. However, we have reasons to believe that the results might not hold for SOV languages. This is because, recent work has found strong evidence for DLM during production in an SOV language like Hindi [6,7]. But, how DLM interacts with Accessibility in SOV languages is still unknown. Thus, we conduct an experiment to investigate how (a) DLM and Accessibility independently shape word-order and (b) the interaction between them, also using Hindi, an SOV language.

Methods

Transitive sentences constituted the critical items. The paradigm used was the sentence recall task. Participants (n=60) viewed the subject, object and the verb in boxes on the screen and were required to mentally construct a sentence using them. Following an arithmetic problemsolving task, they first heard an audio after which they were given the verb as cue to recall the sentence they prepared earlier. See Figure below.



This task allows participants to order their arguments freely and allows us to test naturalistic production under controlled settings [8]. The number of non-canonical OSV sentences was the dependent variable.

Following [5], Accessibility was tested via givenness -- one of the arguments was mentioned in the audio that participants heard. Prior mention/givenness has been found to increase the

accessibility of that argument leading to a given-before-new ordering preference. DLM was tested by manipulating the length of arguments of the to-be-recalled sentence. For SOV languages, a long-before-short preference – putting the longer argument before the shorter argument has been found to decrease the total dependency length of the sentence.

The experiment had a within-subjects 3x2 factorial **design** crossing Givenness (Subject-Given; Object-Given; None-Given) with Argument-Length (Object-Long; All-Short). See Table below.

		All-Short	**Object-Long**
Subject-Given	*shikari bohot nirdayee thaa* (The hunter was very cruel)	*shikari-ne mazdoor ko dhakela* (The hunter pushed the labourer)	*shikari-ne topi pehney hue mazdoor ko dhakela* (The hunter pushed the labourer who was wearing a cap)
Object-Given	*mazdoor kaafi kamzor thaa* (The labourer was quite weak)		
None-Given	*baarish ho rahi thii* (It was raining)		

The critical predictions were as follows:

(a) If Accessibility influences word-order, then we expected to observe a given-before new effect -- more OSV shifts in the Object-Given condition (where givenness would predict OSV order) compared to the None-Given (where givenness would have no predictions, so the canonical SOV order would be preferred) and Subject-Given conditions (where givenness would predict an SOV order).

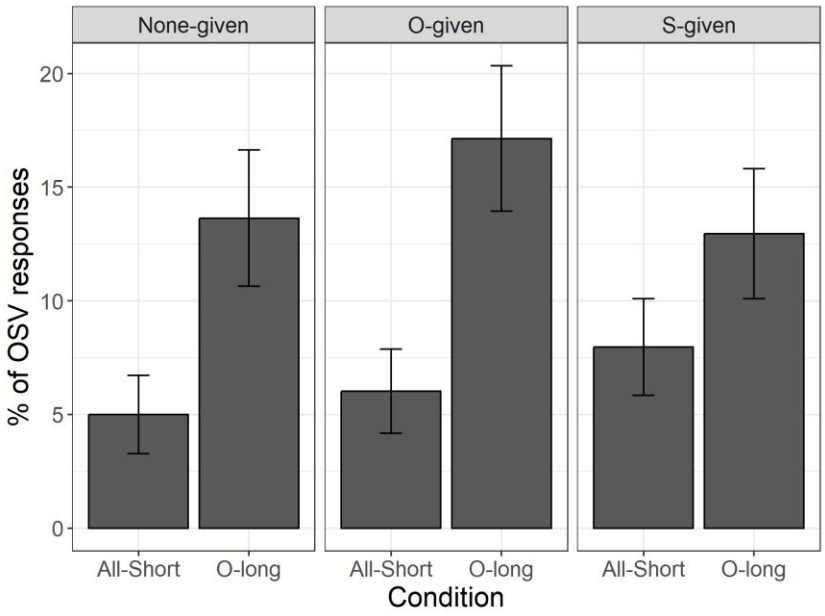
(b) If DLM influences word-order then we expected to observe a long-before-short effect

-- more OSV shifts in the Object-Long conditions compared to the All-Short conditions (because it is an OSV order in Object-Long that leads to DLM).

(c) Additionally, the interaction between Accessibility and DLM would also be tested. If what [5] found for SVO languages also holds for an SOV language like Hindi, then the effect of Argument-Length (long-before-short) should be observed ONLY in situations where Givenness does not predict OSV order – that is more OSV shifts in Object-Long compared to All-Short only in the None-given conditions and not in the Subject-given conditions.

Results

The figure below shows the number of OSV responses produced by participants in the different conditions.



Generalized linear mixed-effects models with a logit link function were used for all analyses. As is deducible from the figure, the number of OSV responses were similar in the three different manipulations of Givenness. In the statistical analysis too, the effect of givenness was not significant (z=0.5, p=0.5). However, the effect of Argument-Length was statistically significant (z= 3.4 ; p<0.001). Since, givenness showed no effect in causing word-order variation in our data, the interaction between Givenness and Argument-Length was also not statistically significant (z=0.7, p=0.4).

Discussion

The results discount the role of Accessibility and align with [6,7] to confirm DLM as a robust determinant of word-order not only during sentence comprehension but also sentence production. DLM entails that planning during production is non-incremental/structural -- speakers must plan in advance the syntactic details/ position of arguments and verbs before beginning to speak to ascertain DLM-aligned word-order. Furthermore, preference for DLM over Accessibility also means that speakers of Hindi prefer global structure building (structural efficiency) over local structure building (lexical efficiency). Why could that be the case? One unique feature of Hindi is the existence of different kinds of forward and backward dependencies for case marking and agreement where local structure building could lead to the production of ungrammatical sentences. One way to avoid this is to keep syntactically dependent words close to each other.

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Investigating the Effect of Orthographic Transparency on Phonological Awareness in Bilingual Children with Developmental Dyslexia: An ERP Evidence

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Introduction

Developmental dyslexia is a neurodevelopmental disorder characterized by reading difficulties despite average intelligence, posing significant challenges for bilingual children navigating languages with varying orthographic systems. Central to understanding dyslexia is the phonological deficit hypothesis, which suggests that individuals with dyslexia primarily struggle with phonological processing—the cognitive processes involved in understanding and using language sounds. These difficulties often include challenges with representing, retrieving, and decoding sounds in language, which can vary depending on the transparency of the orthography, defined by the consistency and predictability of letter-sound relationships. This study addresses a critical gap in dyslexia interventions for bilingual populations in India by examining how orthographic transparency influences phonological processing. In transparent orthographies, such as Kannada, there is a direct and consistent correspondence between letters and their associated sounds, facilitating easier decoding. In contrast, opaque orthographies like English present complex and irregular letter-sound mappings, which pose significant challenges for individuals with dyslexia, often compelling them to rely on compensatory strategies, such as visual or contextual cues. Kannada-English bilinguals were selected for this study because Kannada, the most transparent orthography among Indian writing systems, contrasts with English, the most opaque orthography commonly used in dyslexia therapy in India. Understanding the orthography that promotes better phonological processing can inform the development of targeted bilingual interventions, thereby improving reading outcomes in children with developmental dyslexia.

Methodology

The study involved 22 bilingual children diagnosed with developmental dyslexia, with an average age of 10 years. These participants were native Kannada speakers enrolled in elementary education with English as a subject. To ensure comparability, participants were required to have equivalent reading proficiency in both Kannada and English, as assessed by the Language Experience and Proficiency Questionnaire (LEAP-Q). This was crucial for isolating the effects of orthographic transparency on phonological awareness. The primary endpoints were accuracy and response time in phonological tasks across both languages, with concurrent ERP recordings.

The methodology utilized a computerized visual rhyme-judgment task, a precursor to reading development due to its high demand on phonological awareness. The rhyme judgment task compared reaction times, accuracy, and ERP components (N170, N400, and LPC) for rhyming and non-rhyming stimuli in both orthographies: English and Kannada. As hypothesized, the results demonstrated advantages in phonological processing tasks for the transparent orthography (Kannada).

Results

The behavioural results showed significant differences in phonological processing between the two languages. Children with dyslexia exhibited higher accuracy and faster response times when processing Kannada compared to English. Specifically, the mean accuracy was 85% for Kannada tasks and 70% for English tasks, with a p-value < 0.01 indicating statistical significance. Similarly, the mean response time was 450ms for Kannada tasks compared to

600ms for English tasks, with a p-value < 0.01. ERP recordings revealed distinct neural activation patterns, indicating more efficient processing in the transparent orthography. Brain activity measured by ERP components (N170, N400, and LPC) showed less effort required for processing words in Kannada, as reflected by smaller amplitudes. A repeated-measures ANOVA of peak amplitudes revealed a significant main effect of condition, with participants displaying more negative N400 amplitudes for rhyming Kannada stimuli (M = -769.981 μV) compared to rhyming English stimuli (M = -122.720 μV), indicating a large effect size ($F(1, 20) = 38.819$, $p = .002$, $\eta^2 = .886$). The smaller amplitudes in the ERP components for Kannada suggest that phonological processing tasks are less effortful when the orthography is transparent.

Measure	Kannada	English	Statistical Significance
Mean Accuracy (%)	85%	70%	$p < 0.01$
Mean Response Time (ms)	450ms	600ms	$p < 0.01$
Mean Amplitude (μV)	-769.981	-122.720	$F(1, 20) = 38.819$, $p = .002$, $\eta^2 = .886$
ERP Processing Efficiency	Higher	Lower	

Discussion

These findings underscore the crucial role of orthographic transparency in optimizing reading performance for bilingual children with dyslexia. The implications for educational practices and intervention strategies are significant, suggesting that children with developmental dyslexia benefit from interventions tailored to the orthographic properties of their languages. For instance, employing transparent orthographies in early reading instruction could enhance phonological processing skills and potentially improve overall reading abilities in children with dyslexia. This study advocates for a bilingual approach to dyslexia interventions, where the characteristics of both languages are leveraged to support the child's reading development. Moreover, incorporating these transparent orthographies into intervention programs has the potential to significantly enhance phonological processing, improve reading skills, and foster greater linguistic inclusivity.

In conclusion, this study provides compelling evidence that bilingual children with developmental dyslexia process phonological information more effectively in transparent orthographies. Future research could involve designing Kannada orthography-based interventions at the syllable level and exploring cross-linguistic transfer of reading skills to assess the impact on English reading performance in bilingual children with dyslexia.

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ShabdGyaan: A Pilot Study as a Precursor to Megastudy on Word Recognition, Individual Differences, and Vocabulary Size Estimation

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Introduction

Visual word recognition involves the fundamental processing of words and the mechanisms by which they are identified and understood. This process is shaped by both stimuli-dependent factors like word length and frequency, as well as individual differences such as age of acquisition and lexical skills (Newman, 2016). Research on Indian languages like Hindi encounters challenges due to fundamental script-level differences from Western Romanic languages, such as ill-defined parameters for word length, complexity, and syllable structure. Furthermore, India's linguistic diversity and the use of multiple languages in education complicate the assessment of native-level proficiency, as students in Hindi-speaking regions often attend either Hindi-medium or English-medium schools.

This research is part of a larger study aimed at mapping individual differences in visual word recognition. This research will contribute to understanding population-level vocabulary size and assist in developing tools for estimating individual vocabulary and language proficiency. For our megastudy, we plan to collect lexical-decision data (reaction time and accuracy) from over 300,000 participants, who will complete a 5-minute online task involving 80,000 Hindi words. Before launching this extensive study, we need to address several key questions: What should be the optimal ratio of words *(targets)* to non-words *(distractors)* in the study? How can we design the experiment to effectively capture relevant individual-level variables? What strategies can we employ to minimize participant drop-out rates? To address these questions and test the rigor of our experimental paradigm, we are conducting our first pilot study. This preliminary research will refine our approach for the full-scale megastudy.

Literature review

Similar studies in English, Dutch, and Chinese have identified age, education, and multilingualism as key factors influencing vocabulary size, with word-prevalence scores being a strong predictor of processing times (Keuleers et al., 2015; Brysbaert et al., 2016). Nation (2006) found that 8,000 to 9,000 word families are needed for written text comprehension, and 6,000 to 7,000 for spoken text. However, experimental research on language variability in Indian languages is lacking. Our study aims to fill this gap by examining these factors in Hindi and incorporating script-specific variables.

Methods

(a) Stimuli-set preparation

We began with several Hindi corpora and dictionaries, creating a preliminary list of 400,000 words. After refining this list, we ended up with about 80,000 cleaned words. We then added 40,000 pseudowords, resulting in final stimuli set of approximately 120,000 items (80,000 words and 40,000 pseudowords).

Participants in the study were shown 100 stimuli with varying ratios of words to pseudowords to minimize response bias and aim for approximately equal "yes" and "no" responses. The pilot study used three ratios: 25% pseudowords (75 words), 29% pseudowords (71 words), or 33% pseudowords (67 words). To balance the perception

of words and pseudowords, we adjusted the ratios to ensure participants felt there were roughly equal numbers of each.

(b) Task and Procedure

The current study employed a non-speeded lexical-decision task (LDT) paradigm. Participants began by providing demographic information, including age, educational background, the highest level of schooling in which Hindi was the medium of instruction, self-rated Hindi proficiency, and known languages. They then viewed an instruction page detailing the task before starting the test. Each participant was randomly assigned one of three word lists. The list displayed 100 stimuli, one at a time, at the center of the screen, and participants responded by indicating whether each stimulus was a word or a non-word.

(c) Participants

Data were collected from 110 participants (60 male, 46 female, 4 other) with a mean age of 24; 61 were native Hindi speakers (L1) and 49 were non-native (L2).

Results

Individual differences: We analyzed only words, excluding pseudowords, and calculated accuracy based on correctly identified words. Consistent with prior research, word recognition accuracy improves with age but declines after age 50 *(Fig. 1a)*. The L1 group's mean accuracy was 0.70, while the L2 group was 0.59 *(Fig. 1b)*. A paired-samples t-test showed a significant difference between the groups *($t = 3.31$, $df = 65.674$, $p < 0.001$)*. Pearson correlation analysis revealed a moderate correlation between self-rated proficiency and accuracy *($r = 0.36$, $p < 0.001$, see Fig. 1c)*. Accuracy was highest among participants from middle-income households and declined at both lower and higher income extremes *(see Fig. 1d)*. Further analysis with a larger, more diverse sample is needed to explore socioeconomic and regional differences, and draw more definitive conclusions.

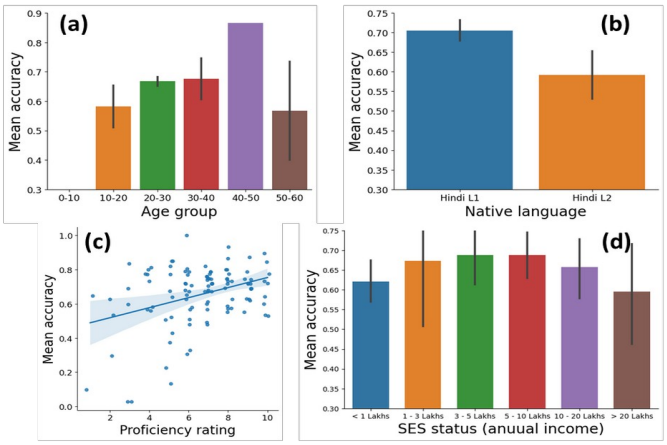

Figure 1: individual differences with mean accuracy on the lexical decision task, (a) age, (b) L1 – L2, (c) self-rated proficiency, (d) annual household income

(a) Stimuli list differences: To minimize response bias towards non-words, we tested three stimulus lists with varying percentages of distractors: 25%, 29%, and 33% nonwords. A one-way ANOVA found no significant differences in performance between the list types *($F(2, 108) = 0.119$, $p = 0.73$)*. As expected, the yes/no ratio was lowest for the 33% nonwords list *(Fig. 2b)*, but this ratio did not significantly affect performance *($F(2, 108) = 2.713$, $p = 0.10$)*. These results indicate that while performance was not significantly influenced by distractor ratios, using the 33% nonwords ratio may still be suitable for the main megastudy.

(b) Stimuli properties: We investigated how word frequency (measured by Zipf values) affected mean accuracy. A one-way ANOVA showed significant differences in accuracy across frequency levels *(F(2, 3317) = 112.2, p < 0.001)*.

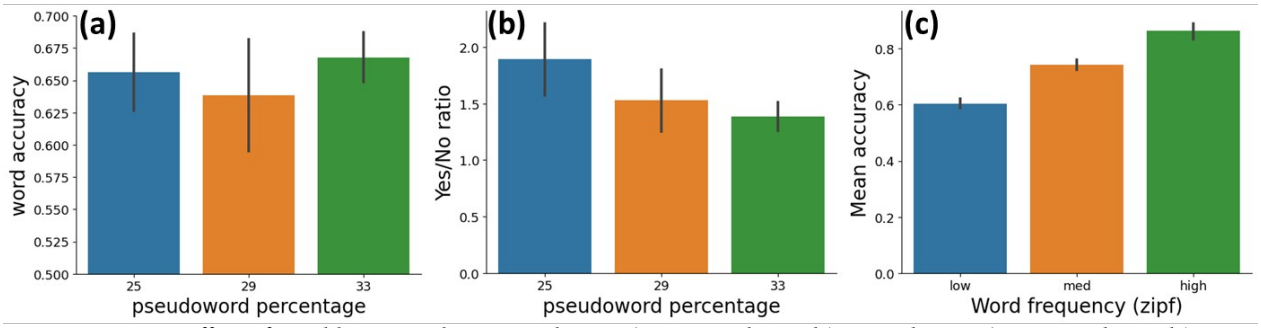

Figure 2: Effect of word list types, here 25 indicates (25% pseudowords), 29 indicates (29% pseudowords), 33 indicates (33% pseudowords), (c) word frequency vs mean accuracy

Discussion

In this study, we replicated key psycholinguistic findings and examined word frequency bias in the lexical decision task (LDT). This pilot study informs critical decisions for our larger megastudy, including using a 33% pseudoword-to-word ratio and incorporating the age of acquisition variable. We plan to expand our sample size to 1,500 participants to assess estimate reliability and prepare for broader data collection. The megastudy is expected to yield insights into nuanced variables like education medium and cultural influences based on participants' state of residence.

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Talk Session 4: Memory

Role of Contextual Cues on the Expression of Competing Motor Memories

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Introduction

A key aspect of brain function is storing, maintaining, and retrieving multiple memories of the environment when the need arises. It is known that context plays a crucial role in learning and memory. Previous studies have shown that the expression of multiple motor skills relies on the formation of distinct motor memories [1], and contextual cues act as neural fingerprints tagging motor memories and enhancing the ability to recall specific motor memories [2]. In motor adaptation, when opposite perturbations are randomly applied, interference between their memories hinders adaptation. Studies have shown that pairing each perturbation with a distinct sensory cue enables robust adaptation to both scenarios [3,4]. The COIN model [5] proposes that contextual cues are crucial for guiding memory formation by reducing interference among competing motor memories. These cues facilitate the segregation and stabilization of motor memories, enhancing the efficiency of learning and recall mechanisms necessary for adaptive motor skills. Although there is substantial research on how contextual interference impacts memory expression, the understanding of the mechanisms underlying the expression of competing motor memories remains unclear. Our study aimed to explore how contextual cues influence the formation and expression of competing motor memories and to uncover the underlying mechanisms.

Methods

The experiment involved 144 right-handed participants, who were seated in front of a virtual reality system consisting of a digitizing tablet and a semi-silvered mirror positioned below a high-definition display. Participants used a stylus on the tablet to perform a point-to-point reaching task. The design of the experiments was based on the ABN paradigm, which consisted of baseline, memory acquisition, and memory expression blocks. Following 150 baseline trials, in the memory acquisition block, they adapted to the cursor rotation (30° counterclockwise or clockwise) based on contextual cues (Task-A or Task-B, respectively), which varied with training schedules and amount of practice. During the memory expression block, participants completed 100 error-clamped trials (Task-N) where the cursor movement was clamped to zero degree error.

Results

In our first experiment (n=36), we aimed to determine if interference could be prevented by contextual cues, even when the task was learned for a very short period of time. Subjects performed 160 trials of Task-A followed by a brief 20 trials of Task-B during the acquisition block. During the expression block, the contextual cue presented differed based on the groups assigned.

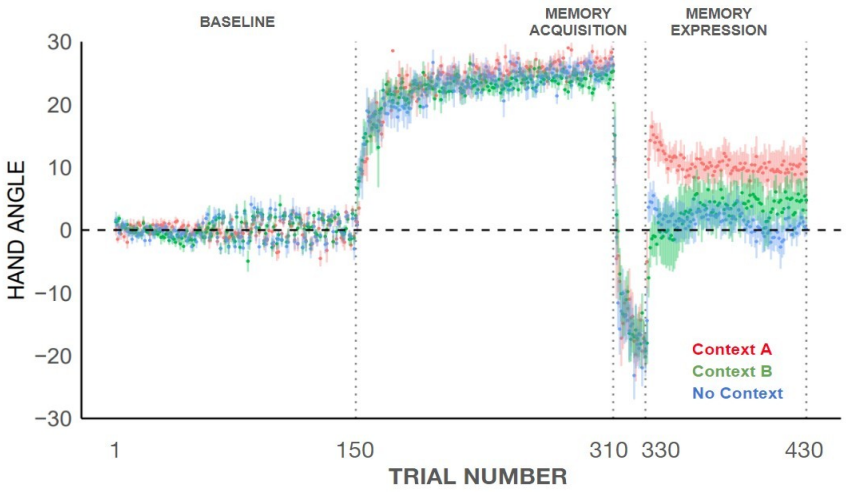

Figure 1: Expression of distinct motor memories are facilitated by the contextual cues presented in the memory expression block [Experiment-1].

The result demonstrates that presenting contextual cues can prevent interference, facilitating the expression of distinct motor memories even without any relevant task errors.

In Experiment-2 (n=36), we aimed to determine if multiple memories, when equally stable, would lead to the expression of the most recent memory. In the acquisition block, subjects performed 160 trials of Task-A, followed by 160 trials of Task-B, and the expression block was the same as in Experiment-1.

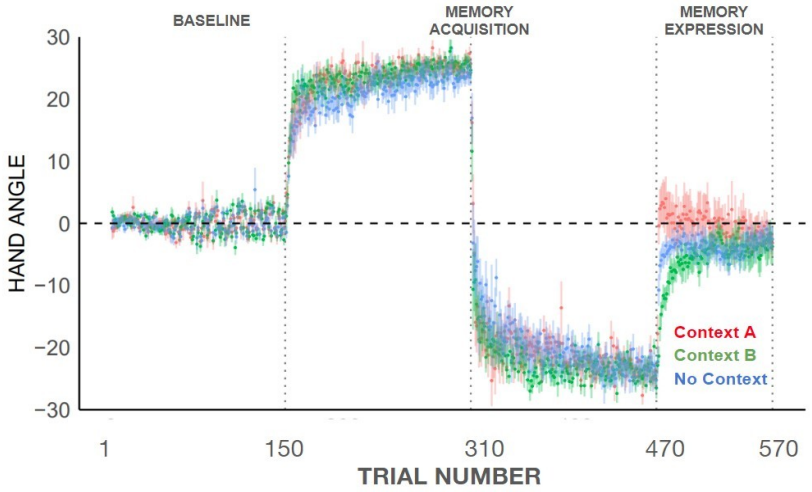

Figure 2: Memory expression is biased towards the most recent memory irrespective of the presented contextual cues in the memory expression block [Experiment-2].

The findings suggest that, regardless of the contextual cues presented, when multiple memories are equally stable, the expression is biased toward the most recent memory.

In Experiment-3 (n=12), we explored whether contextual cues can prevent interference between multiple memories when these memories are expressed in a dynamically changing environment. The acquisition block was the same as Experiment -1, but the expression block comprised 100 trials in which all three contextual conditions were presented in Task-N in a pseudo-randomized manner.

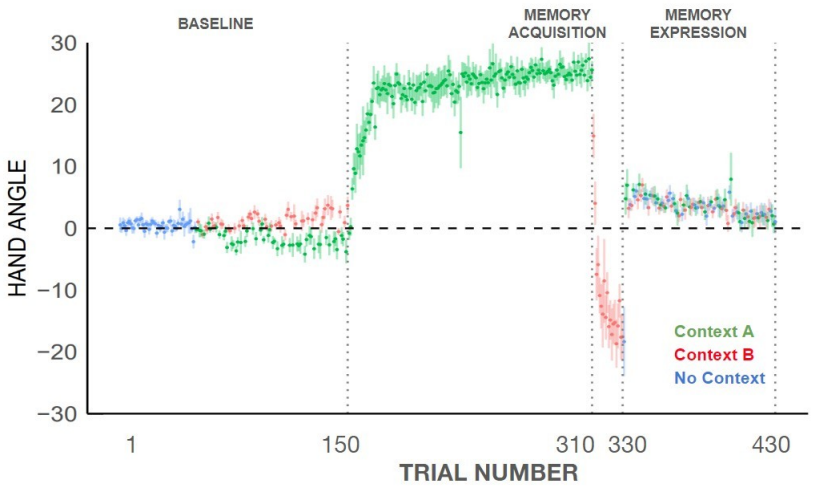

Figure 3: Expression of memory is biased towards the most stable memory during the dynamic environment in the memory expression block [Experiment-3].

The result indicates that multiple memories are not expressed independently in a dynamically changing environment; instead, they are biased toward the most stable context.

In Experiment-4 (n=12), we tried to investigate whether the interference in individual expression is prevented if the multiple memories are stabilized equally. The acquisition block was similar to Experiment-2, but the expression block had 100 trials of interleaved contextual conditions in Task-N.

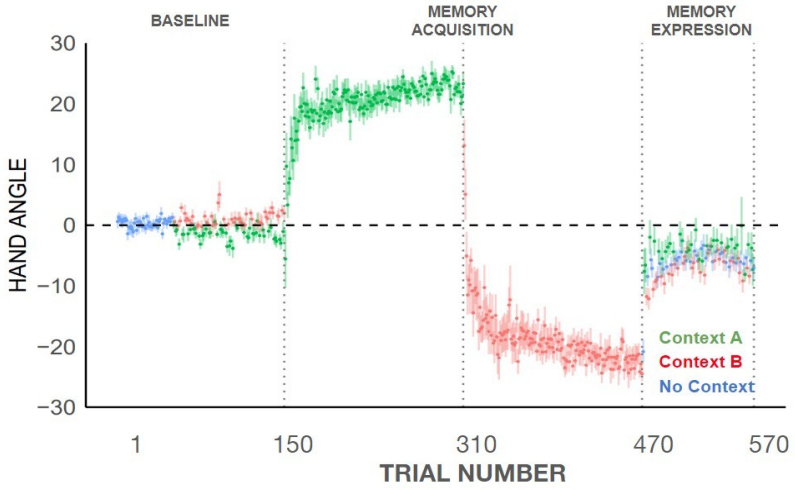

Figure 4: Memory expression is biased towards the most recent memory in the dynamic environment memory expression block [Experiment-4].

The result suggests that in a dynamically changing environment, multiple stable memories cannot be expressed independently when these memories are equally stable, and memory expression tends to be biased toward the most recent memory.

In Experiment-5 (n=36), we aimed to unravel if multiple memories learned in a dynamically changing environment can be expressed in a constant environment. Participants were presented with 320 interleaved Task-A and Task-B trials during the acquisition block, and the expression block was the same as Experiment-1.

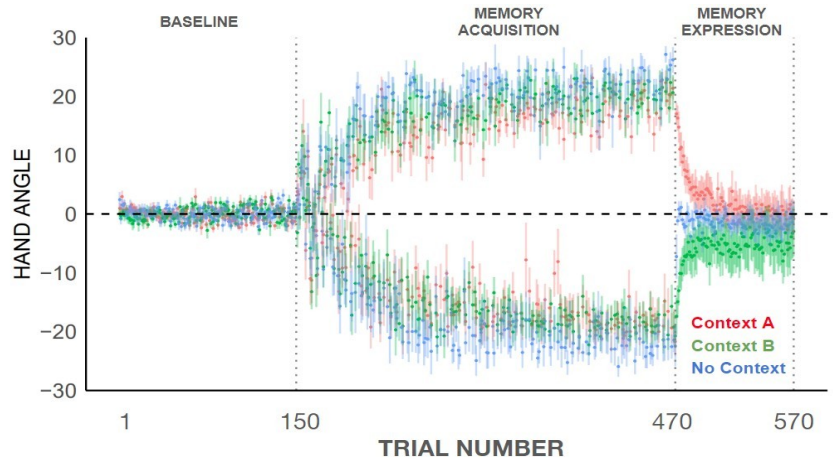

Figure 5: Independent expression of multiple competing motor memories happens depending on the contextual cues presented in the memory expression block [Experiment-5].

We found that distinct memories can be expressed independently based on the contextual cues presented when learned in a dynamically changing environment.

In Experiment-6 (n=12), we aimed to investigate whether contextual cues prevent interference if multiple memories are learned in a dynamically changing environment. The acquisition block was the same as Experiment-5, and the expression block consisted of all three contextual cues presented randomly.

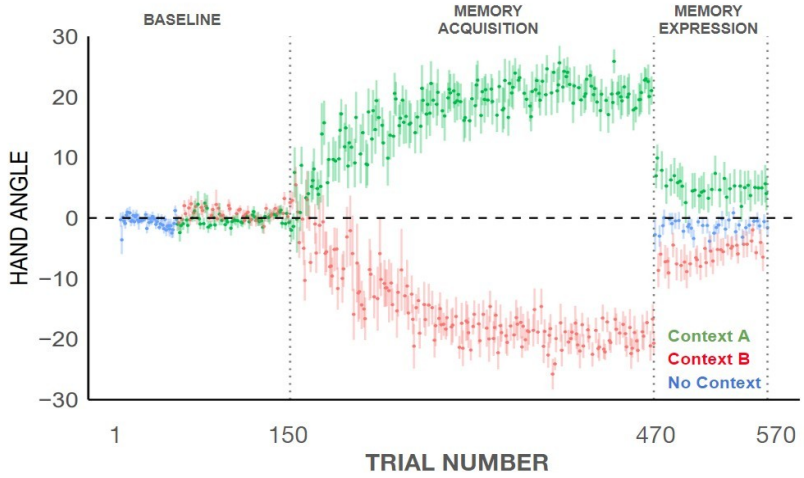

Figure 6: Multiple competing motor memories can be expressed independently in memory expression block with dynamic environment [Experiment-6].

The result suggests that if learned in a dynamically changing environment, multiple competing memories can be expressed independently in a randomly changing environment.

Discussion

The result of this study suggests that attaching contextual cues can result in the stable expression of multiple competing motor memories which goes in line with previous research. Our findings demonstrate that the expression of motor memory does not depend on task errors and can be triggered by encountering relevant cues. Additionally, the expression of motor memory appears to be influenced by both the stability and recency of these contextual

cues. This suggests that stable and recent contextual information plays a crucial role in guiding the formation and expression of competing motor memories.

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Effect of Value-Based Decision on Intentional Cognitive Offloading for Prospective Memory

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Introduction

Successful navigation of daily life relies on our ability to encode and retrieve intentions for future actions. This cognitive faculty is termed prospective memory (Kvavilashvili, 1987). Prospective memory ensures we remember to perform these planned actions at the designated future time. However, our mental capacities are limited for prospective memory with a 50% to 70% failure rate (Crovitz & Daniel, 1984). To remember these types of tasks, we use external aids like alarms, sticky notes or even leaving things at convenient places like leaving keys next to the door. These are examples of external cues that we intentionally set to support our memory in order to improve the likelihood that we will recall delayed intents. It's referred to as intention offloading (Risko & Gilbert, 2016).

There is a greater value associated with some intents than others. In other words, not remembering them will result in a higher penalty, but completing them will lead to a greater reward. This claim is supported by some evidence, like this study which found people who use more efficient encoding techniques, including deep semantic encoding, facilitate the retrieval of high-value items (Cohen et al., 2017).

In sum, studies have shown a relation between value and prospective memory. However, in these studies the participants had to complete tasks without any external aids. In everyday life we have multiple tools and devices to help us. This would then make us question how much does the value associated with the task affect our memory systems which extend beyond our brain?

The attempt at answering this question has majorly been through self-reports, where the participants reported higher offloading for high value tasks. However, this has seldom been explored experimentally (Dupont et al., 2023). This study therefore aimed to investigate how value attached to delayed intention tasks influence participants' use of internal store or external store (offloading) through a designed experiment.

Method

The study employed a within subject design, where each participant completed two conditions, the experimental condition (offloading allowed) and the control condition (no offloading allowed). The study included 55 participants [Mean age= 28.7 years, SD= 11.8]. To participate, participants had to be above 18 and fluent in English. Exclusion Criteria included participants taking any medications that could affect their memory and cognition, who have an ongoing psychological illness and those experiencing visual impairment that could interfere with their performance in the experiment.

An original online game was designed, based on a classic experiment by Einstein & McDaniel for prospective memory (Einstein & McDaniel, 1990). The game was modified to have 3 rounds. First, to establish the ongoing task; second, to introduce the cue and the prospective memory task and third, which allowed participants to offload the prospective memory task.

Procedure

A pilot study [n=20] was done and the experiment was validated. The experiment was performed on a laptop where the participants could access the game through a link. Data was collected both online and in person.

Statistical analysis

The non-normally distributed data was analysed using the Wilcoxon signed-rank test. Chi-square test was used for categorical variables of value. P<0.05 was considered statistically significant in all of the analyses.

Results

There were three groups of findings, Contrary to our first hypothesis, participants had no significant difference in accuracy of responses in the no offloading allowed condition and the offloading allowed condition [$W(120019)$, $p < 0.001$]. Supporting our second hypothesis, participants had faster reaction times in the Offloading Allowed condition compared to the No Offloading Allowed condition [$W(670943)$, $p < 0.003$]. Contrary to our third hypothesis, participants did not use reminders more frequently for higher valued cards compared to lower valued cards in the Offloading Allowed condition [$\chi^2 = 0.767$, $p = 0.381$].

Discussion

The findings suggest that the ability to recall intentions may not be heavily influenced by the availability of external aids, at least in terms of accuracy. However, the finding that reaction times were faster in the offloading condition supports the idea that external aids may enhance the efficiency of memory retrieval, allowing participants to perform tasks more quickly when offloading is permitted.

Interestingly, the lack of a significant association between task value and offloading behaviour suggests that participants may not consistently prioritise high-value tasks when deciding to use external memory aids. This could indicate a more complex interaction between perceived task importance and the decision to offload, potentially influenced by factors such as available time for offloading and meta-memory judegemnts. This insight could inform the design of more effective memory support tools that better align with how people naturally prioritise and manage their intentions.

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Manipulating Boundary Conditions: Prediction Error and Memory Strength to Initiate Memory Reconsolidation

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The emergence, maintenance and persistence of disorders such as anxiety and posttraumatic stress disorder (PTSD) involve learning and memory mechanisms. Fear-conditioning paradigm is commonly used to model these mechanisms in experimental studies. Traditionally, fear is acquired by co-presenting a conditioned stimulus (CS) with an aversive stimulus (US) for a certain number of trials called reinforcement schedule until a conditioned response (CR) is generated. Standard extinction (SE) training involves presentation of CS without the US until the CR ceases to exist in the behaviour. These standard-extinction methods have often resulted in the recovery of CR termed as relapse (Dunsmoor et al., 2015). The CR recovery happens due to the non-erasure of the existing fear memory developed during the acquisition phase (CSfear) and then creating a competing new memory for the same CS (CS-safe) which can or cannot be expressed under certain circumstances (Dunsmoor et al., 2015). Recent behavioural approaches have employed single CS presentation without the UCS before extinction called post-retrieval extinction (PRE) (Auber et al., 2013). This method is rooted in the memory reconsolidation theory- where consolidated memories are reactivated to make them labile and susceptible to change. This reminder serves as a window- here original memory (CS-fear) can be updated by safety learning (CS-safe) utilising extinction training (Schiller et al., 2012). These methods have demonstrated superior results in presenting fear return when compared to SE (Agren et al., 2012; Kitamura et al., 2020; Schiller et al., 2012; Thompson & Lipp, 2017). Though, PRE has successfully prevented the return of fear (ROF) among humans; on the contrary, many studies have failed to replicate the findings (Asthana et al., 2015; FernandezRey et al., 2018; Thome et al., 2016). These findings show conditions that can limit the effectiveness of memory destabilizing procedures called boundary conditions. The potential boundary conditions of memory are age (Björkstrand et al., 2015, 2016; Steinfurth et al., 2014), strength (Golkar et al., 2012; Thompson & Lipp, 2017) and the conditions of reactivation (Hu et al., 2018; Li et al., 2017). However, scarce research is available on memory strength and the degree of Prediction Error (PE)- mismatch in the anticipated event as potential boundary conditions.

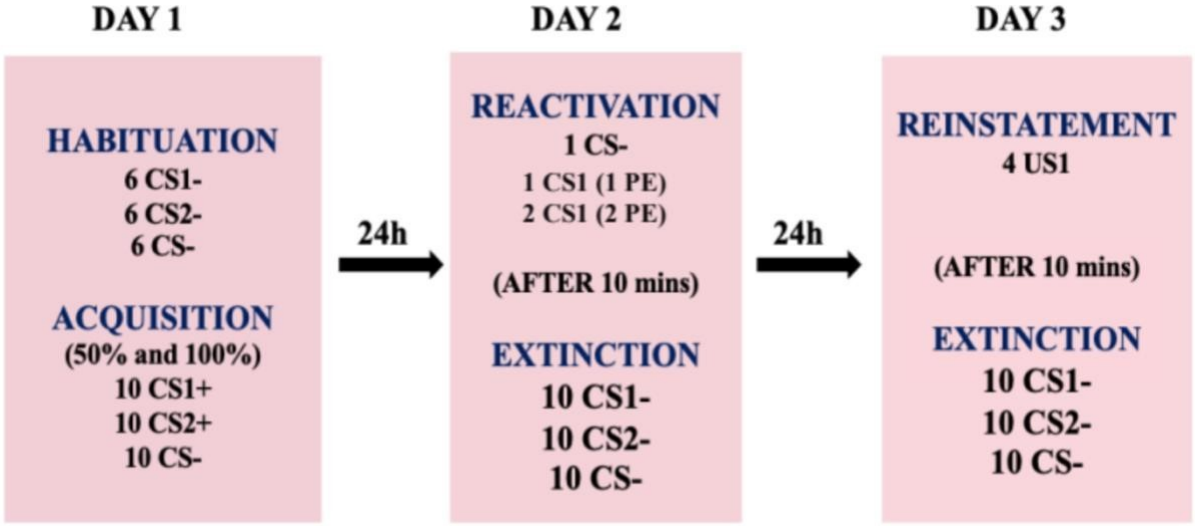
The present study aims to examine the effect of partial and continuous reinforcement schedules and different degrees of PE by conducting three major investigations:

A) Assessing group difference in ROF between standard and PRE
B) Examining the effect of memory strength- partial and continuous (50% and 100%) reinforcement on post-acquisition expectation and physiological responses during memory reactivation
C) Examining the effect of the degree of PE on memory strength, post-acquisition expectation and physiological responses during memory reactivation.

On a sample of eighty-four participants (39 females) (M_{age}=20.3, SD = 3.72), we used CS reactivation to produce PE. A three-day fear conditioning paradigm (refer to Figure 1) was used: acquisition (50% and 100%) on Day 1, CS Reactivation or control on Day 2, and extinction learning and reinstatement on Day 3. Data were collected using both subjective measures- expectancy ratings, STAI-T (Spielberger, 1989), BDI (Beck et al., 1961) and physiological responding using SCR. Three grey geometrical figures (circle, square and triangle) were used as CSs, two aversive images were chosen from the International

Affective Picture System (IAPS; Lang et al.,2008); two aversive sounds were chosen from the International Affective Digitized Sounds system (IADS-2; Bradley & Lang, 2007).

Figure 1
Experimental Design



Note. This figure demonstrates phases of the experiment following three-day fear conditioning paradigm. On day 1 acquisition, participants were subjected to ten presentations of each stimulus (within-groups) at either 50% or 100% reinforcement schedule (between-groups). On day 2, only the CS1+ was reactivated twice (1 PE) and thrice (2 PE) to see the degree of PE effective on memory strength (between group). One of the stimuli that was paired with the shock during acquisition would undergo post-retrieval extinction (CS1+), whereas the other, standard extinction (CS2+) (within-groups). After memory reactivation, all stimuli were presented without reinforcement to extinguish conditioned responses. On day 3, extinction was followed by reinstatement after the presentation of four unsignalled shocks.

In the study, we find that extinction training was unsuccessful in preventing fear in reinstatement tests. Retrieval – extinction decreased reinstatement when expectancy was violated. Our findings indicate that Expectancy violation or prediction Error (PE) serves as a necessary condition to destabilize consolidated fear memory. However, the degree of PE required for destabilization strongly depends on the strength of memory. Our study highlights that two consecutive CS1s (2PE) was not enough to destabilize stronger memories (100% reinforcement) whereas for weaker memory (50% reinforcement), a single CS1 presentation (1PE condition) could destabilize the memory.

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Talk Session 5: Learning

Interlimb Differences in Implicit and Explicit Learning Processes

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Motor adaptation is the process through which individuals learn to adjust their motor output in response to environmental perturbations. Such learning is driven by multiple mechanisms ranging from implicit refinements to internal models of the body and the world, to verbally sensitive strategic mechanisms that act to rapidly cancel perturbation-induced errors (Taylor et al., 2014). Previous work probing whether motor adaptation differs across the limbs has generally found no significant differences (Kumar et al., 2020). Yet, it remains unknown whether the component mechanisms that drive adaptation differ across the limbs. This study therefore examined interlimb differences in implicit and explicit learning processes in visuomotor adaptation. In experiment 1 (n=80), we used the "clamped" feedback method known to solely induce implicit learning as demonstrated by Morehead et al (2017). Here, a feedback cursor was rotated by ±45° relative to the direction of a reach target, regardless of the direction of the underlying hand movement. In experiment 2 (n=30), adaptation was induced via explicit strategies by delaying the feedback provided to the participants about the presence of the visuomotor rotation as shown by Honda et al. (2012). Perturbations were induced only in the clockwise direction. Experiment 1 revealed surprising and significant interlimb differences in implicit learning, with the left arm adapting more than the right. However, these effects were tied to the direction of the rotation; differences were evident only for the clockwise but not the counterclockwise rotation. Further analyses indicated that differences were robust only when subjects reached to targets located in the ordinal direction but were unreliable for cardinally located targets. In contrast, no interlimb differences were seen in strategy use in Experiment 2. Collectively, these findings indicate that implicit learning likely differs in a direction-sensitive manner across the dominant and non-dominant limbs. This work adds to the growing body of literature on mechanistic differences in motor control and learning across the two limbs, and calls for a more nuanced interpretation of the contribution of different learning mechanisms when different effectors adapt to motor errors.
Keywords: implicit learning, explicit learning, interlimb differences, clamped feedback, delayed feedback, visuomotor adaptation

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Contextual expression of motor adaptation does not update the existing motor memories

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Motor adaptation is the process by which individuals maintain the accuracy of motor movements in response to changing environmental conditions. This process involves modifying actions to compensate for perturbations caused by environmental changes, thereby preserving performance accuracy (Krakauer et al., 2019). A critical factor in motor adaptation is context, which encompasses the environmental properties, states, and dynamics present during the formation of motor memories. Context aids in differentiating, storing, and expressing these memories (Heald et al., 2021). Each motor memory is associated with distinct sensory cues from the environment, which differentiate one context from another and, consequently, one motor memory from another. These sensory cues are crucial for the brain's inference of the current context, which subsequently influences motor memory formation, expression, and modification (Heald et al., 2021). Investigating motor adaptation across different contexts enhances our understanding of how multiple motor memories are formed, stored, and retrieved when necessary or how new memories are created or existing ones updated when the sensory feedback does not match any existing sensorimotor contingencies. Research indicates that unique sensory cues for different perturbations can establish distinct contexts, thereby preventing interference—where memories of different perturbations would otherwise inhibit each other, impeding the adaptation process. Assigning unique sensory cues to different perturbations can facilitate the simultaneous development of robust adaptations (Heald et al., 2021).

A Bayesian model has been proposed to elucidate the contextual features of motor learning. The COIN (COntextual INference) model is based on an internal model that envelopes the learner's assumptions about how environmental sensory observations are generated. This theory suggests that adaptation can occur through both the creation and updating of memories (referred to as proper learning) and through alterations in how existing memories are differentially expressed (referred to as apparent learning) (Heald et al., 2021). Previous literature has suggested that actions are executed when a specific context is activated based on estimations of the current context and inferences drawn. These actions are then evaluated and either lead to updating the existing memory or creating a new memory based on the feedback received (Heald et al., 2021; 2023). While sensory cues which help in contextual inference play a critical role in determining the creation and modification of motor memories, it is still not established if these memories are actively updated when they are being expressed in response to environmental cues or if they remain stable during the execution of learned motor tasks.

Further experimentation and analysis are required to elucidate the mechanisms that govern memory updating during the expression. To test this question, an experimental task was designed in which participants were seated in front of a virtual reality (VR) setup. A semi-silvered mirror was used to present the screen while obstructing the participants' view of their hands. Participants were instructed to move a stylus across a digitizing tablet to perform a point-to-point reaching task. The experiment was structured using an ABN paradigm and divided into four blocks. Following a baseline phase of 150 trials, Context A (perturbation of -30 degrees) was presented for an extended duration of 160 trials, followed by Context B (perturbation of +30 degrees) for 20 trials. This was followed by an expression phase consisting of 100 error-clamped trials. One group received context A in clamped trials,

another had B context in clamped trials, and the third group had no context in the clamped trials. The final phase was relearning, in which Context A was presented again for 160 trials. Another control group was also recruited where participants did not have the expression phase, instead, they were given a break of the same duration as the expression phase.

We hypothesized that when a particular contextual cue is presented during the expression phase, the existing motor memory gets activated for expression, which makes that existing memory labile. During this period, the expression of the memory might result in updating the existing motor memories. This update of the existing motor memory can be reflected in interference in relearning the previously learned task. The preliminary findings show that the expression of motor memory under different contextual cues presented in the expression phase did not update the existing memory, and savings were observed in the relearning session. This suggests that just expression of the existing motor memory does not update the previously acquired memories. This leads us to the further question whether the introduction of errors during this expression phase might modify or update the existing memory, which will be visible in the relearning phase, for which the data collection is in progress.

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Role of Working Memory in Interlimb Generalization of a Newly Learned Motor Skill

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Introduction

Newly learned motor skills can be generalized to an untrained arm. Such interlimb generalization of skilled movements has been shown to be symmetric (interlimb generalization of skill learning from the right to the left arm and vice versa) and is thought to be mediated by cognitive processes that can influence newly acquired skill memory (Yadav and Mutha, 2020). Recently, it was demonstrated that working memory can interact with skill memory, particularly when the skill is acquired in a variable task environment. Studies have suggested that the Dorsolateral Prefrontal

Cortex (DLPFC) is involved in the encoding, consolidating, and retrieving variable skill memories (Kantak et al., 2010). Skill-learning representations are likely to be formed in circuits that include the DLPFC and posterior parietal cortex (PPC), which are also essential for working memory (Curtis and D'Esposito, 2003; Fregni et. al., 2005). However, it is unclear how working memory interacts with newly formed skill memory and influences interlimb generalization of newly acquired motor skills.

Methods

This study involved 92 healthy and right-handed participants who provided written informed consent. Handedness was measured using the Edinburgh Handedness Inventory (Oldfield, 1971). They were monetarily compensated. The Institute Ethics Committee approved all procedures.

Participants performed planar movements on a digitizing tablet using a stylus, with visual stimuli (start circle, target, cursor) reflected through a one-way mirror that blocked the direct view of their hand. Movements had to be fast straight, and reach one of five randomly presented targets within 650 ms, following a specified path. After each trial, feedback on spatial and temporal errors and motor errors was provided. The number of trials in the skill training session was 160 in experiment 1 & 2. In experiment 3, the trial number was reduced from 160 to 50. In the generalization session, the trial number was 160 in all experiments.

After training, participants completed a visuospatial working memory task. In working memory condition, participants observed 3-5 white squares (from a 9-square) flash red color in a random sequence for 750 ms and reproduced the same sequence. Participants moved their hands over static red squares without the spatial memory component in the control condition. Total number of trials was 80 in both working memory and control conditions.

Result

In Experiment 1 (Immediate Group), both the control and working memory conditions showed a significant reduction in total motor error from the first to the last training bin [$F(1, 30) = 305.51$, $p < 0.001$, $\omega^2 = 0.20$]. A significant difference was also observed between the last training bin and the first generalization bin [$F(1, 30) = 31.09$, $p < 0.001$, $\omega^2 = 0.02$], with no condition effect, indicating successful interlimb generalization from the trained to the untrained hand in both conditions. The visuospatial working memory task did not affect this generalization.

In Experiment 2 (Delayed Group), a similar reduction in motor error was observed during training [$F(1, 28) = 323.73$, $p < 0.001$, $\omega^2 = 0.22$]. After 24 hours, interlimb generalization was still evident, with a significant difference between the last training bin and the first

generalization bin [$F(1, 28) = 82.98$, $p < 0.001$, $\omega^2 = 0.06$] and no condition effect, suggesting that the secondary task did not impair interlimb generalization.

In both experiments, generalization was consistent across working memory and control conditions, suggesting that long training sessions allowed participants to reach asymptotic performance, minimizing the requirement for working memory. To test the impact of visuospatial working memory on shorter training durations, we reduced trials from 160 to 50 in Experiment 3 (Shortdelayed Group).

In Experiment 3, participants who underwent shorter training sessions (50 trials) showed significant motor skill improvement [$F(1, 28) = 147.03$, $p < 0.001$, $\omega^2 = 0.82$]. However, interlimb generalization was impaired in the working memory condition compared to the control condition after 24 hours. A significant interaction between bin and condition was found [$F(1, 28) = 5.10$, $p = 0.003$, $\omega^2 = 0.12$], with higher motor errors in the working memory group during the generalization session ($t[28] = -3.51$, $p = 0.0015$). This suggests that short training, followed by a visuospatial working memory task, impairs interlimb generalization after 24 hours, unlike longer training sessions where generalization remains intact.

Discussion

The current study aimed to examine the role of working memory in the interlimb generalization of motor skill learning. Newly acquired motor skills were tested for generalization to the untrained left arm immediately or 24 hours after training. In Experiment 3, generalization was impaired when participants engaged in a secondary visuospatial working memory task following a short training session. In experiment 1, participants reduced preparation time and successfully generalized to the untrained arm. Experiment 2 showed a reduction in preparation time and increased movement speed during training, and both strategies were applied in the generalization session. However, in Experiment 3, the preparation-time strategy developed during the short training session was impaired during the generalization session in the working memory condition. This suggests that engaging in a secondary visuospatial working memory task immediately after a brief period of skill training interferes with the stabilization of the learned skill. Notably, this disruption affects the movement preparation strategy without affecting the movement speed, resulting in the preparation time strategy not being generalized in the untrained arm.

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Talk Session 6: Perception and Action

Do You See an Object to Use It or to Hold It: Role of Structural and Functional Actions in Object Processing

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Actions associated with objects are tightly linked to their object concepts, a relationship demonstrated by facilitation of concept processing by action priming. However, not all actions have equal influence on processing of concepts, functional actions are thought to play a stronger role in concept processing, shown using a Stroop task (Bub et al., 2008) and priming in an object recognition task (Ni, Liu & Yeu, 2019) while structural actions provide little benefit for semantic access in a match-mismatch task (Bellis et al., 2016).

Our aim was to investigate the relationship between structural actions and processing of object concepts. In Experiment 1, fifty-two participants volunteered to participate in a match-mismatch task regarding either functional or volumetric properties of objects, after they were either primed by structural or by functional actions matching one of the objects, or not primed (a blank screen was presented in place of action prime). We demonstrate that both actions compared to a no prime condition provide some benefit in a categorization task related to a semantic property, i.e., functional similarity [$F(1,29) = 8.971$, $p = 0.006$, $\eta = 0.236$] and a volumetric property, i.e., size similarity [$F(1,29) = 7.424$, $p = 0.011$, $\eta = 0.204$] of objects; where that action knowledge is irrelevant. However, we see that people are faster yet less accurate when primed by functional actions. Thus, the results are non-conclusive about functional actions. Interestingly though, in contrast to previous work, for priming, we find the effect size is greater for structural than for functional actions. The benefit of priming by structural actions can be explained as structural actions being linked to volumetric property of objects more strongly; an object property like size would be necessary to guide reachinggrasping actions (Caprara et al., 2018). The notion that only functional actions or the Use system is related to long-term representations of objects, or dominant to object concepts is challenged by the evidence we find in this experiment. Both actions seem to be integral to object concept processing, but when one is more influential depends on the context. In order to identify the priming effects better, we conducted another experiment where we have a neutral prime condition. This would also help us dissociate the priming effects we observed in Experiment 1 to identify whether a priming effect truly exists, especially in the functional actions case, and also dissociate the benefit provided by priming in comparison to no prime versus non-beneficial information.

In Experiment 2, fifty-one participants, different from Experiment 1, volunteered to participate in the same match-mismatch task regarding either functional or volumetric properties of objects after they were either primed by structural or by functional actions matching one of the objects, or by a neutral action gesture (presented for the same amount of time as the action prime). We fail to find a priming benefit in the categorization task when primed by either structural or functional action compared to the neutral action. Previous work have shown strong functional action priming benefits in object recognition task (Ni, Liu & Yeu, 2019); and in match-mismatch task where the object was itself present with the prime (Bellis et al., 2016). In absence of repetition priming and compared to a no prime condition, when it comes to a non-beneficial prime like a neutral prime, we do not observe any priming benefits. Thus, the two types of actions, functional and structural, differ not only in terms of their strength of association to the objects but also the benefits of activation of actions is

dependent on the kind of categorization task and context (Kalénine et al., 2013). Therefore, more studies need to be conducted in different task contexts to identify and separate out the benefits and the differential role played by these two action systems in concept processing of objects.

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Negligible Allocentric Representation Benefits in Contextual Cueing Effects

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Introduction

The familiarity of an environmental context is often determined by the consistency in the visuospatial characteristics of the environment. For instance, it is natural to expect to walk through the main door of a house, and enter the living room, and not the kitchen or the dining area! The general idea about the layout of a house is derived from previous experiences of the typical layout of houses in India. It is assumed that the general idea about immediate environment is acquired automatically and implicitly over time with repeated exposure of the environment, thus constituting the environmental context (Theeuwes, 2018). Such a *familiar* context facilitates a rapid, efficient, and successful goal-directed search for a particular object when required, and such facilitation is often termed as contextual cueing effect (Jiang & Sisk, 2020).

The contextual cueing effects have been demonstrated experimentally using the visual search paradigm, where the paradigm is adapted in such a way that distractor locations remain invariant throughout the experiment and participants not kept informed about this invariance (Chun & Jiang, 2003). As the experiment proceeds, the target selection becomes efficient- reflected in terms of shallower search slope and lower intercept, implying an efficient search. Since the participants are not aware of any consistency in the location of the search items, it is assumed that the search efficiency enhancement across time is due to the implicit and automatic manner in which the configuration (location) of the search items is learnt.

That is, traditional studies have operationalized context in terms of the consistency in the interspatial arrangement of the search items. Studies have shown that violations to the consistency of the location of the search items result in reaction time costs. Such a conceptualization of the context implies an allocentric representation of the visuospatial information in contextual cueing literature. The present study aims to see the extent of the manifestation of the contextual cueing effect when all the search items are subjected to equal locational distortions, thus still maintaining the overall consistency in the inter-spatial arrangement of the search items.

Method

32 young adults (21 males, 11 females), all right-handed with normal or corrected to normal vision, participated in the study. The experiment was designed on MATLAB using Psychtoolbox (PTB-3). Stimuli were presented on a computer screen with resolution 1920×1080 pixels; refresh rate: 60Hz. Participants were shown a search display in which ten alphabets appeared on various locations on the screen, out of which they had to search for the target letters E or F among other distractor alphabets and make keypress responses as fast and accurate as possible. Items were presented in locations that formed six imaginary concentric circles, with each circle having eight locations on it.

The experimental protocol consisted of a Learning phase and a Transfer phase. In the Learning phase, participants were presented with Ten fixed configurations, each appearing thirty times. Thus, the learning phase consisted of 300 trials, equally divided into 6 bins. Whereas, the Transfer phase consisted of 120 trials, equally divided for, the configurations shown in the learning phase (old configurations), the old configurations rotated 90° (clockwise or counterclockwise), and new set of configurations that the participant had not encountered in the learning phase. The time taken to respond to the target was recorded in both the Learning and the Transfer phases.

Results

Learning Phase:

A one way Repeated Measures (RM) ANOVA performed on the mean Reaction Time (RT) obtained from 6 Bins revealed significant main effect, F(3.95, 122.51)=18.86, P=.001, ηp2=.37. There was significant reduction in the RT from the first bin (M=1238 ms) to the sixth bin (1067 ms), indicating implicit learning of the ten configurations with its repeated presentations (Fig. 1).

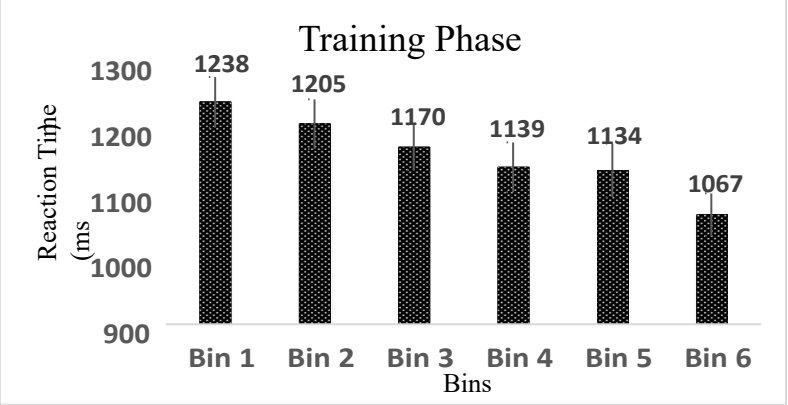

Fig. 1: Mean response time obtained for Bin 1 to Bin 6

Transfer Phase:

A one-way RM ANOVA performed on the mean Reaction Time (RT) obtained for the types of configurations [0°, 90°, and New; Fig. 2] revealed significant main effect, F(1.83, 56.89)=44.89, P=.001, ηp2=.59.

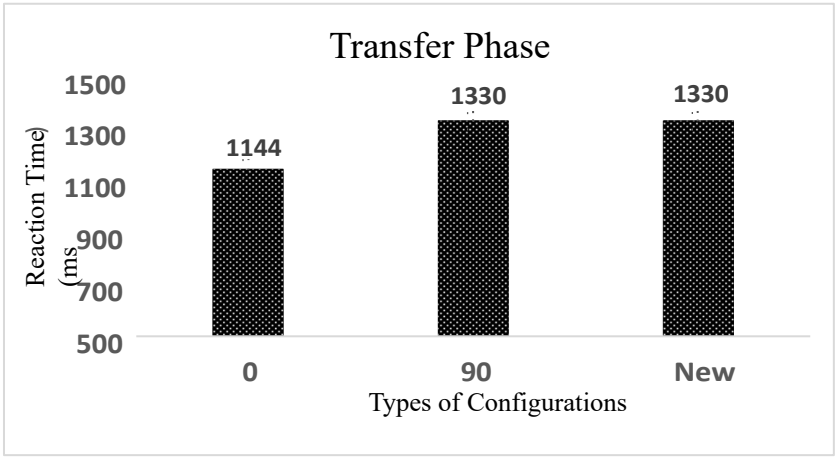

Fig. 2: Mean response time obtained for the types of configurations: '0' and '90' implies no rotation and 90^0 rotation, respectively, of the Ten old configurations. Whereas, 'New' implies a randomly generated new configuration.

The mean RT for old (repeated) configuration was significantly lower than both 90° rotated and new configurations, implying that the participants were relatively quicker to respond to the old configuration when they encountered them again in the transfer phase. However, a 90° rotation of the learned configuration resulted in an RT cost equivalent to that of a totally new and random configuration.

Discussion

The present study aimed to test the robustness of the contextual cueing effect, if all the search items were subjected to equal locational distortions; specifically, a 90° rotation (from its old spatial configuration). Such a manipulation maintains the overall consistency in the interspatial arrangement of the search items of the learned configuration and is therefore expected to leave the contextual cueing effect intact in the rotated condition.

However, the present finding of similar RT cost for both rotated as well as a new configuration, relative to the learned configuration, imply that the contextual cueing effect is not entirely driven by the inter-spatial arrangement of the search items (allocentric representation). A purely allocentric representation of the learned configuration should have resulted in similar RT for both old and rotated configurations. Therefore, the current findings question the inferences of the previous studies that have operationalized context in terms of the inter-spatial arrangement of the search items. Future studies need to be done to reveal other factors that seem to be driving contextual cueing benefits.

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Investigating perceptual boundaries of Self-Priortization effect in Abstract Shape Paradigm using Priming effect

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Introduction

The concept of self plays a fundamental role in shaping how we engage with the world around us, influencing our perceptions of both our own actions and those of others. Research indicates that the prominence of social stimuli, particularly whether they are relevant to the self, can significantly impact our attentional processes (Sui, 2016). Existing studies have largely focused on stimuli with established associations, such as images of one's own face (Bredart et al., 2006). The self-reference effect underscores the phenomenon wherein individuals exhibit enhanced memory for information personally relevant to them compared to less personally significant material. This self-reference effect essentially highlights the cognitive advantage conferred by relating information to oneself (Sui & Humphreys, 2015). In exploring the influence of self-reference on lower-level perceptual processing, recent research has delved into shape association tasks. Sui et al. (2012) conducted perceptual matching experiments wherein participants associated labels with geometric shapes, revealing a notable advantage for self-referential labels over others such as those pertaining to best friends, mothers, strangers, or neutral labels. Their findings suggest that linking a stimulus to the 'self' can indeed modulate subsequent perceptual processing (Sui & Humphreys,, 2013). Sui et al. (2012) first illustrated preferential processing of self-using the perceptual matching task, and more than a decade later it has overcome various criticisms such as word length

effect, concreteness effect, etc.

In clarifying out longstanding criticism of self prioritization effect (SPE) in abstract shape paradigm (ASP), whether in the simple perceptual matching task of shapes and social labels, we tap into perception (Golubickis & Macrae, 2022), or not.

We conducted social labels-based priming where the target will be shapes associated to and social labels will be used as primes. Since priming seems to process automatically, priming effects should be shown in target processing (Drieghe & Brysbaert, 2002). This study explores the boundaries of the self-prioritization effect in perceptual judgments, specifically within an abstract shape paradigm. To investigate this, we employed priming techniques to examine how self-relevance impacts perceptual decision-making for socially associated abstract shapes.

Methods

In the experiment (n =27, (mean Age =25 years, SD = 4.3 years; 13M, 10F) of which we dropped 4 participants), the learned shape-label mappings had one-to-one mapping for shape exemplar and social-label (myself/stranger) during the association phase.

Association experiment: All experiments were conducted in two distinct stages to systematically assess participants' responses. The first stage involved an association task [fig. 1], wherein participants were tasked with memorizing the shape-label pairings. Initially, participants were presented with two geometric shapes (triangle, square) accompanied by labels indicating "myself" and "stranger." Following this, participants underwent a practice trial of the association matching [fig. 1] to evaluate their learning of the associations. Only participants achieving an accuracy rate exceeding 75% proceeded to the subsequent main experiment (where 4 participants were dropped), ensuring the remembered association of shapes with their social labels. To ensure a balanced presentation, the association of these

shapes to social labels was counterbalanced across participants. After the association phase participants were instructed to do a simple categorization task (main task).

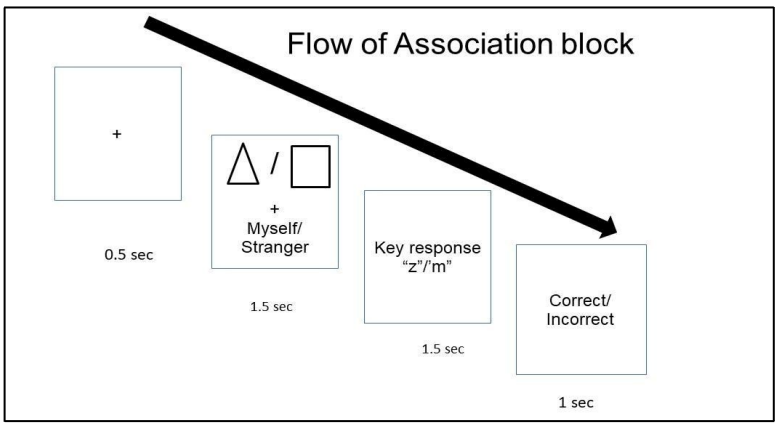

Fig.1 Association trial block of the experiment (matching response: "z" / non-matching: "m")

Main Experiment**:** Single trail structure is such that after fixation cross (250ms) the primes-labels: "myself" / "stranger" was presented for different time stamps (17ms, 34ms, 51ms, 68ms), this prime was pre- and post-masked with "########" which appears for 50ms then targets (associated-shapes: triangle/quadrilateral) would appear for 100ms and response window will be for 1000ms, where the participant is required to reply with 'A' & 'L'[fig. 2]. If the shape presented is self-associated then they have to respond with 'A' key, If the shape presented to them belongs to stranger then they have to respond with 'L' key, this mapping is counterbalanced as well. The experiment is provided with 60 practice trials, 256 *4 (for each time stamp) =1024 main trials in 4 repetitions with breaks after every 256 trials.

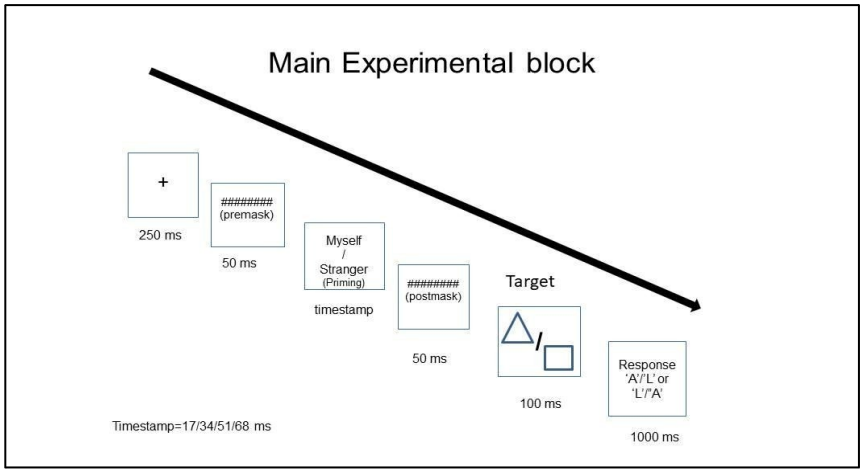

Fig.2 Main trial block of the experiment (categorization task)

Results

We carried out 2 (Prime-label: Myself, Stranger) x 2 (Target-shape: Myself, Stranger) x 4 (Time_stamp: 17ms, 34ms, 51ms, 68ms) within-subjects repeated measures ANOVA for average Accuracy and Reaction Times (RT's). For Accuracy, there was a significant main effect of only Time_stamp, $F(3, 66)=3.010$, $p=0.036$, $\eta^2_p=0.120$, while there was no significant effect of Prime-label, Target-shape or any interactions.

Descriptives

Primes	Time_stamp	Target	Mean	SD	N
Stranger	17	Stranger	0.411	0.052	23
		Myself	0.412	0.055	23
	34	Stranger	0.408	0.052	23
		Myself	0.404	0.057	23
	51	Stranger	0.406	0.050	23
		Myself	0.398	0.053	23
	68	Stranger	0.403	0.049	23
		Myself	0.399	0.062	23
Myself	17	Stranger	0.410	0.050	23
		Myself	0.400	0.049	23
	34	Stranger	0.415	0.053	23
		Myself	0.394	0.055	23
	51	Stranger	0.397	0.053	23
		Myself	0.398	0.056	23
	68	Stranger	0.404	0.050	23
		Myself	0.393	0.049	23

Table 1: Mean and SD Reaction times across all times stamps, prime-labels and target-shapes

For RT's there was a significant main effect of Prime-label, $F(1, 22)=4.741$, $p=0.040$, $\eta^2_p=0.177$ and the significant main effect of Time_stamp, $F(3, 66)=4.701$, $p=0.005$, $\eta^2_p=0.176$, while no significant effect of Target-shape or any interaction [fig.3].

Then, we looked at the post-hoc analysis for reaction times showed which significantly faster responses for self-label primes (Mean RT=0.393±0.052 seconds) than they responded to stranger-label primes (Mean RT=0.405±0.054 seconds) with $t(23)=-2.177$, $p_{holm}=0.040$, $d=-0.066$ [fig.4]. Subsequently, they were significantly slower in responding when the primes were shown for 17ms than when primes were shown for 51ms and 68ms with $t=3.113$, $p_{holm}=0.016$, $d=0.161$ and $t=3.015$, $p_{holm}=0.018$, $d=0.156$. There were no significant differences between response times when primes were presented for 17ms versus 34ms but slower for 17ms with $t=1018$, $p_{holm}=0.625$, $d=0.053$ [fig. 5].

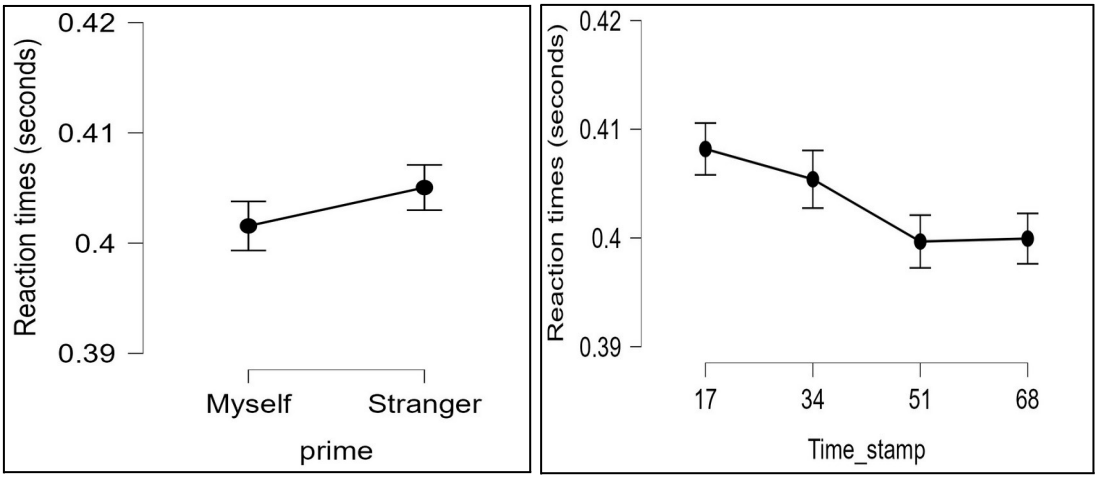

Fig 3: RT plot across prime-labels (left) & RT plot for different time stamps (right) [error bars are 'se']

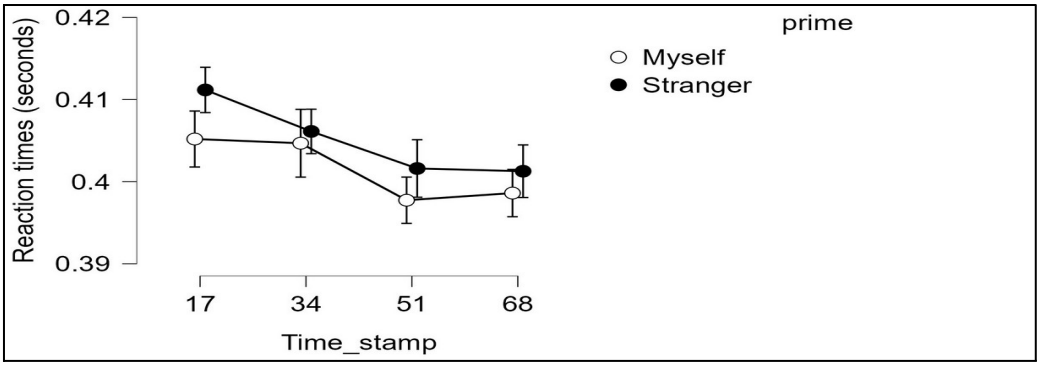

Fig.4: RT plot with prime-labels across different time stamps [error bars are 'se']

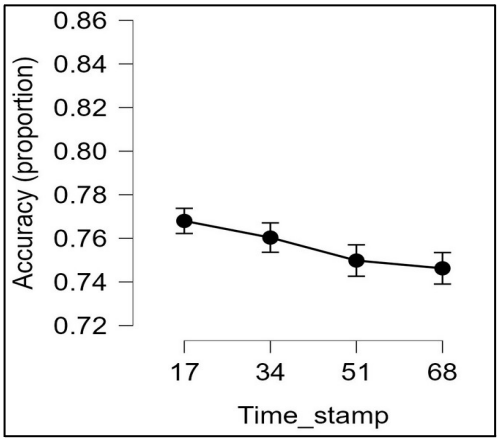

Fig 5: Accuracy plot for different time stamps [error bars are 'se']

Discussion

In the shape categorization task, the effect of priming with the more salient label "myself" resulted in faster responses than when primed with the less salient label "stranger". We also found the significant main effect of the priming duration (time_stamp) on both the Accuracy

and RT's of our responses. Post-hoc analysis of RT's revealed significantly for the shortest priming duration of 17ms than higher duration of 51ms & 68ms. Even though there was no significant difference in accuracy within the priming durations, the difference between 17ms and 68ms tended towards significance (p_{holm}=0.055). Overall we do find a significant self prioritization effect in responses following being primed with the salience of 'self'. The results have implications for strengthening the claims of a perceptual benefit from self-referent processing. The findings from this study from manipulating the temporal distances of primes (different durations of priming with social labels) on targets (socially associated shapes) and evaluating the effects on perceptual accuracy and response times, we observed that self-prioritization is most pronounced when associated shapes are primed using self-label, and priming effects diminish with temporal distance. These results delineated the different conditions under which self-prioritization may be manifested and maximized and contribute to a deeper understanding of the perceptual boundaries and temporal dynamics of the self-prioritization effect, highlighting the nuanced ways in which self-relevance influences perceptual judgments.

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Talk Session 7: Cognitive Control /Decision Making/Actions

Hand dominance does not influence EEG-EMG coherence during grasping

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IIT Madras

Introduction

Corticomuscular coherence is a widely applied and established method for measuring the synchrony between neural signals and muscle activity during voluntary movements. This can be calculated by estimating coherence between electromyography (EMG) and electroencephalography. There is a common notion that the hemisphere contralateral to the dominant hand is thought to influence bilateral coordination, reflecting complex neural pathways [1]. This study aimed to examine the relationship between the neural–muscular coordination in the dominant and non-dominant hand during lifting tasks under two different conditions.

Methods

Participants and Experimental protocol

Twenty right-handed adults (mean age = 26.95, STD = 2.68) participated in this study. A handle was designed especially equipped with five Nano 17 force sensors to measure the 6-component force/torque for each finger. The thumb force sensor was placed on a movable slider, while the other sensors were fixed on the opposite side (Fig. 1). The 0.75 kg handle, included a displacement sensor for the thumb position and an IMU sensor for handle orientation measurement. A two-channel EMG and twenty-two channels EEG system was developed using INTAN RHD 2216 bio amplifiers. A 64-channel EEG cap was used to record EEG signals from 22 channels. Surface EMG signals were collected from the flexor digitorum superficialis (FDS) and flexor carpi ulnaris (FCU), muscles essential for gripping and manipulating objects.

Participants were instructed to hold the handle gently for a 5-second, and asked to lift and hold it in the air for another 5-seconds. The study included 25 trials for each condition (fixed and free), for each hand with breaks provided between trials. Digit force, displacement and orientation data were sampled at 100 Hz, and EEG/EMG signals were sampled at 1500 Hz, and recorded using LabView code.

EEG and EMG signals were filtered to remove the 50Hz powerline interference then band pass filtered (4–40 Hz–EEG signals, 20–500 Hz–EMG signals). Mean squared coherence was calculated between the C3 channel and the FDS muscle of the right hand, and between the C4 channel and the FDS muscle of the left hand between 2 – 4 seconds of the holding phase. Coherence was obtained by normalizing the cross-spectrum of the EEG and EMG signals [2].

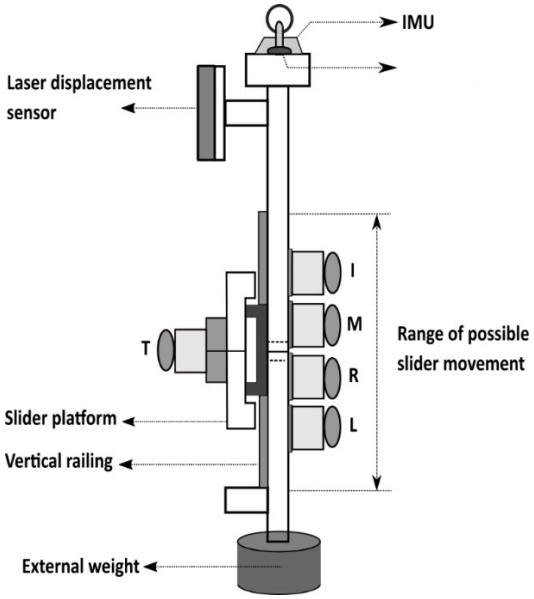

Fig. 1. Instrument handle.

Results

A two-way repeated measures ANOVA on EEG-EMG coherence with factors task conditions and hands showed that the CMC magnitude was higher in the fixed condition than the free condition for both hands. No difference was observed between hands in either condition (Fig. 2). Since there was no difference observed on the factor hand, Two One-Sided Test (TOST) was performed to examine the equivalence between the conditions. TOST procedure (equivalence bounds: $\Delta L = -1.04$ and $\Delta U = 1.04$, - based on SESOI) revealed a statistical equivalence on the EEG-EMG coherence between the hand for the two task conditions.

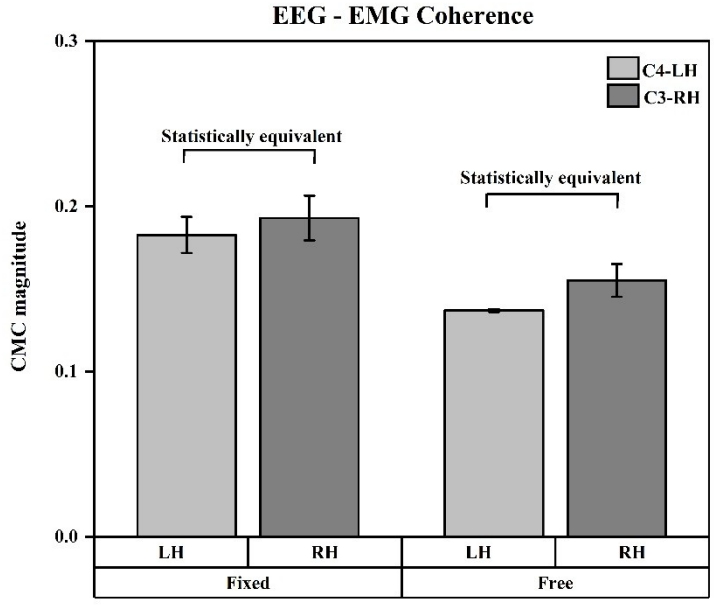

Fig. 2. EEG – EMG coherence. Results are reported in the mean ± S.E.M

Discussion

The study aimed to explore neural and muscular coordination differences in dominant and non-dominant hands during lifting tasks under different conditions. The hypothesis proposed that EEG-EMG coherence would be higher in the non-dominant hand, suggesting greater control or coordination demands compared to the dominant hand. Contrary to the hypothesis,

no difference in magnitude of CMC was found between hands. CMC magnitude was higher in the fixed condition compared to the free condition.

In both the task conditions, the task involves lifting and holding the handle in static equilibrium for five seconds is similar to maintaining a static force after lifting. The higher CMC magnitude in the fixed task condition is due to the sustained muscles contractions which eliminate the need for dynamic adjustments. The similar CMC magnitude between dominant and non-dominant hands suggests both hands perform tasks similarly during the steady-state phase, aligning with previous findings [3], [4]. This may be due to the demand of the task is to maintain the steady state force, which might require muscle strength, and involvement of sustained contraction of muscles. The result can be seen as, despite the differences between the two hemispheres in the dominant and non-dominant hand representations, the overall performance or functions of the hands may not show differences.

In the free condition, changed friction between the platform and the thumb is perceived by the proprioceptors and the cutaneous receptors. Adjusting the grip and tangential forces of the fingers the equilibrium of the handle is maintained [5]. This adaptive strategy showcases the hands' ability to modulate force application in response to task demands by modulating their force application. The reduction in CMC during free conditions suggests finger force coordination changes due to altered friction, aligning with findings in two-finger pinch grasps of varied compliant objects. [6]. Essentially, the fingers must work more independently and precisely to stabilize the handle, which disrupts the typical synchronous muscle activity seen in more stable conditions.

Taken together, these results show that in tasks requiring static force maintenance, both the dominant and non-dominant hands perform similarly due to reliance on muscle endurance rather than fine motor skills. The reduction in CMC during the free condition can be seen as adjustments highlighting the hands' adaptive capabilities in response to varying task demands.

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Attribute trade-off difficulty modulates the asymmetric-dominance of the decoy

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Introduction

A widely studied cognitive bias in decision-making is the ’attraction effect’ or ’asymmetric dominance effect’ (ADE), where introducing a third option influences decision-makers to prefer one of the original options over the other. The studies by Choplin and Hummel (2005) and Trueblood et al. (2013), which demonstrated attraction effects even in the perceptual domain, became essential milestones in establishing the effect’s ubiquity and challenging the value-based explanations. Still, many recent studies using perceptual tasks (Spektor et al., 2018, 2022) have reported reversed effects, leading to the domain generality of the phenomenon being questioned.

The prominent models of context effect assume that choices are made based on pair-wise ordinal comparisons of alternatives. Adopting one such model (Srivastava & Schrater, 2015) that explicitly considers the decoy’s dominance asymmetry as part of the model’s working, we predicted that low attribute trade-off difficulty would mute the attraction effect by breaching the asymmetric dominance of the decoy. We tested this via a mixed design study with perceptual stimuli where we manipulated the between-subject variable ‘trade-off difficulty’ and the within-subject variable ‘salient pair’. We hypothesized an interaction effect. To manipulate trade-off difficulty, we designed a novel perceptual task making the inter-attribute trade-off difficult. The ’salient-pair’ factor was manipulated by making the target-decoy (TD) pair salient in one condition and the competitordecoy (CD) pair salient in another. We further tested whether stimuli, with difficult-to-trade-off attributes, would produce a positive attraction effect when trials with all three possible salient pairs were randomly arranged.

Method

Thirty-eight students (5 female) with normal or corrected to normal vision, aged 18-25 years, participated in the study. In each trial, the stimuli consisted of three different, gray-colored shapes on a white background, arranged in a triangle around the center of the screen, with their vertical positions jittered across trials.

The stimuli for the low TOD group were filled rectangles, with the two attributes being the rectangles’ width and height. Participants were asked to identify which of the three rectangles appeared to have the largest area. The stimuli set was created following Trueblood et al. (2013).For the high TOD group, each shape was derived from a rectangle with four distinct parts removed. The removed parts were two pairs of inward isosceles triangles whose bases were equal to and touched the four sides of the rectangle. The resulting shape was a star-like shape. Figure 2 panel A and B display two sample trials. The two attributes that formed the attribute space were the width of the base rectangle and the height of each of the four removed triangles. Participants were instructed to find the one shape requiring the least amount of extra colored parts to extend it to form a perfect square.The two stimuli aligned horizontally, at the base of the upward-facing triangle, formed the salient pair. This pair was considered salient due to the ease of comparison between alternatives displayed side by side, horizontally rather than obliquely.The relative share of the target (RST-equal-weight) (Katsimpokis et al., 2022) was used as an index of the effect.

Results

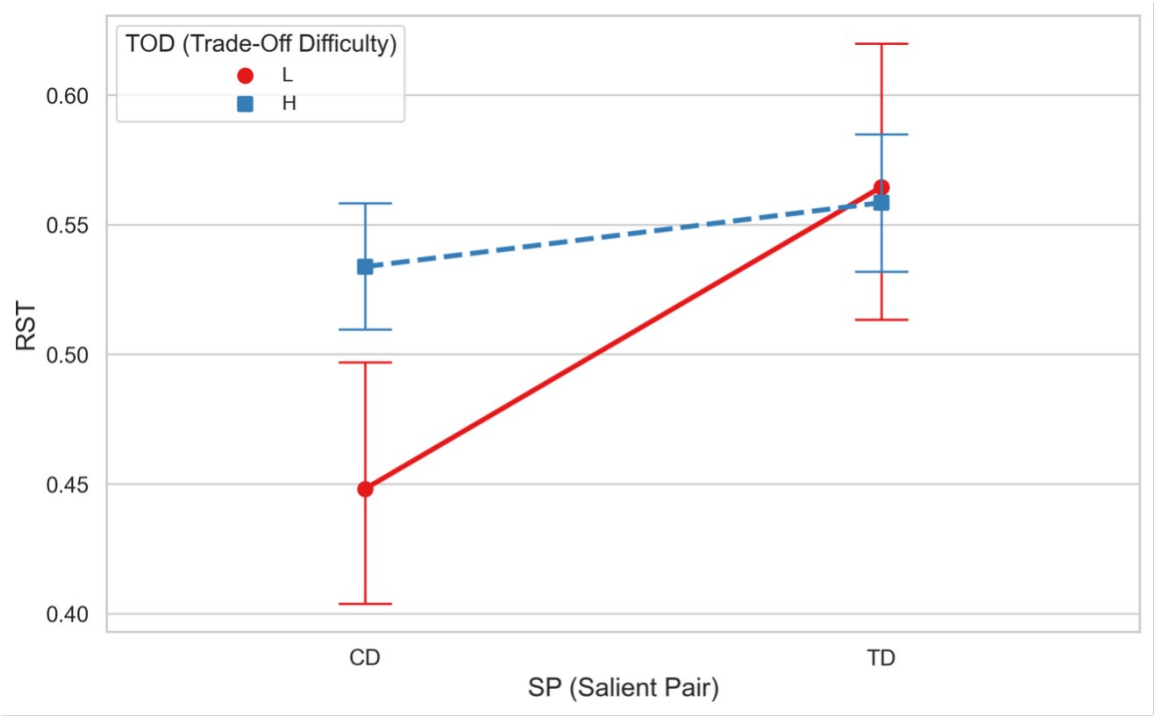


Figure 1: RST by TOD (Trade-Off Difficulty) and SP (Salient Pair).

Note. Error bars are 95% confidence intervals.

A mixed-design ANOVA was conducted to examine the effects of trade-off difficulty (TOD; Low vs High) and salient pair (SP; CD vs TD) on the RST. The main effect of *TOD* was significant, $F(1, 144) = 3.96$, $p = 0.048$. $\eta_p^2 = 0.027$. The main effect of *SP* was significant, $F(1,144) = 12.01$, $p = 0.001$. $\eta_p^2 = 0.077$, and the interaction effect of *TOD* × *SP* was significant, $F(1,144) = 5.26$, $p = 0.023$. $\eta_p^2 = 0.035$.

Figure 1 shows the interaction plot.

Further, when trials with all three possible salient pairs (*TD, CD, CT*) were randomly arranged, we computed the RST for each subject. In other words, we treated it as a separate experiment in which the stimuli with difficult-to-trade-off attribute values had their positions randomized. An independent sample one-tailed t-test was performed to compare the RST values against the null value of 0.5. The mean RST ($M = 0.545$, $SD = 0.047$) was significantly higher than the null value of 0.5; $t(37) = 5.871$, $p < 0.001$, *Cohen'sd* = 0.952, with a Bonferroni correction applied for multiple comparisons. Figure 2 shows two example trials and overall choice share distribution in the two contexts for the high TOD group. Figure 3 depicts a corresponding violin plot with overlayed 95% confidence interval for the overall RST values.

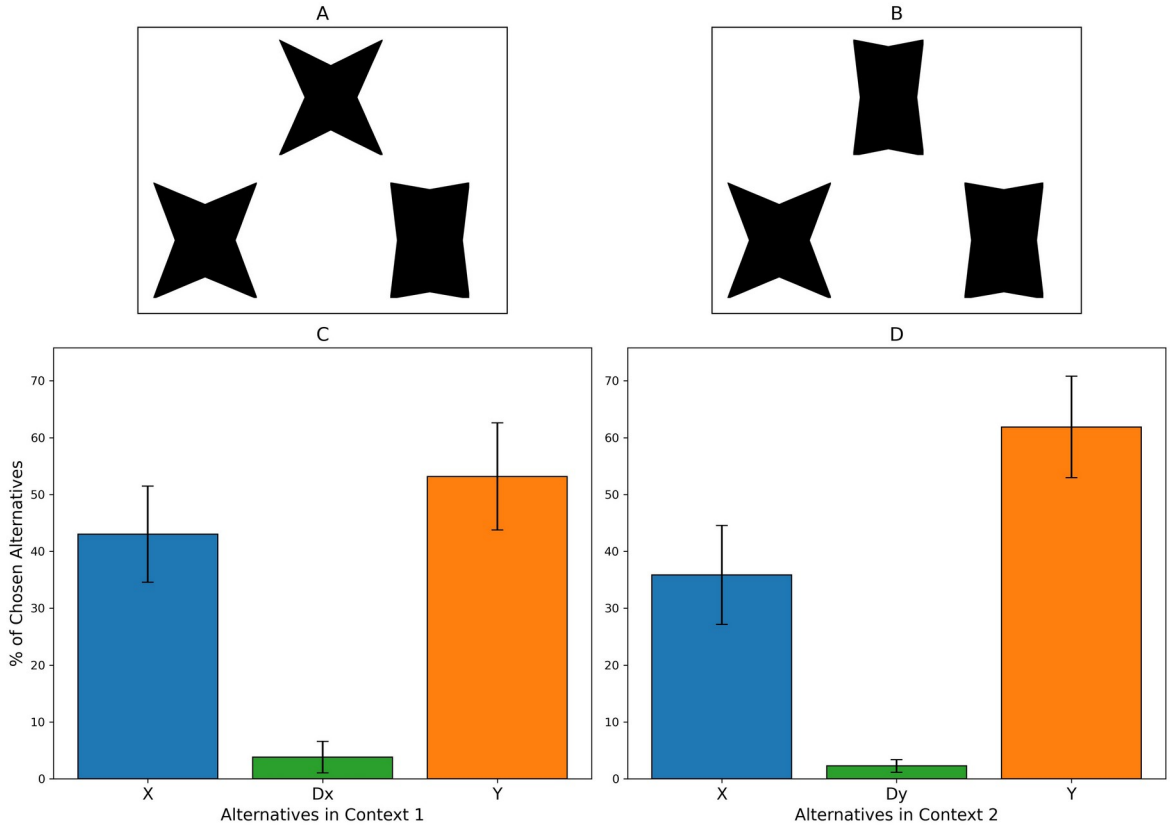


Figure 2: Example trials and Choice Shares in high TOD (Trade-Off Difficulty)

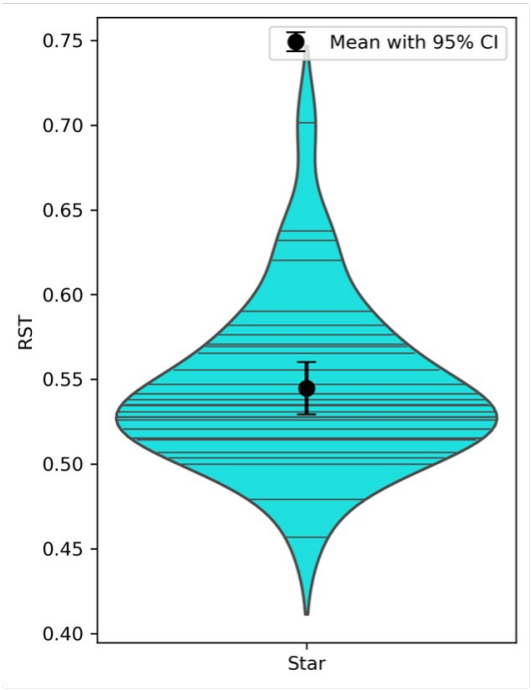
Note. Panel A shows a trial with the wider stimulus as the target, while panel B shows the narrower stimulus as the target. Panels C and D display choice shares for two contexts, with X and Y as core options, and Dx and Dy as decoys favoring X and Y, respectively. Error bars are 95% confidence intervals.

Discussion

As hypothesized, we observed an interaction effect in the mixed-design study, indicating that TOD modulated the saliency effect. Specifically, the saliency effect was more pronounced under low TOD conditions than under high TOD conditions. In the low TOD condition, the salient CD pair led to a negative RST, suggesting that the decoy(D) was dominated by the competitor(C). Similarly, the salient TD pair led to a positive RST, suggesting that the decoy was dominated by the Figure 3: Overall RST for the high TOD (Trade-Off Difficulty).

target(T). Thus, taking both conditions, the decoy was symmetrically dominated by the target and the competitor, consistent with our prediction that low TOD would breach the asymmetric dominance of the decoy, thereby muting the overall attraction effect. Moreover, this result corroborates the pair-wise ordinal comparison model, which posits that alternatives are compared pair-wise.

Given our results, one might question why stimuli, with low attribute-trade-off difficulty, arranged linearly rather than triangularly, did Trueblood et al. (2013) observe a standard attraction effect, which was later replicated by Spektor et al. (2018). We propose that the matched orientation of the stimuli makes the target-decoy pairs consistently salient, regardless of their position in a trial, leading to overall positive effects. This assumption is reasonable. Indeed, the Multiattribute Linear Ballistic Accumulator (MLBA) model (Trueblood et al., 2014) makes a similar assumption to explain the same positive effect.



To sum up, we made two important contributions in this work. First, we re-established the domain generality of the attraction effect by showing a strong positive effect even with perceptual stimuli in an alignment previously known to have produced negative effects. Second, we showed that trade-off difficulty modulates the asymmetry in dominance of the decoy and thereby controls the overall attraction effect.

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‘Sounds like a skill issue’: what makes you quit at chess?

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Introduction

What determines the transition towards stopping an activity? This has been studied as a class of problems called ’optimal stopping problems’ (OSPs) where the goal is to decide when to stop collecting information in order to obtain the best possible outcome for a sequence of presented options. The problems come with the constraint that one cannot return to foregone options. Mathematically, the solution follows an optimal strategy where an option is chosen based on its relative/absolute value surpassing a threshold. Threshold parameters derived from optimal stopping models lack psychological relevance and are uninformative about the process underlying this threshold formation (Bugbee & Gonzalez, 2022).

From a metacognitive perspective, deciding to stop can be framed as deciding an optimal computation for selecting a stopping strategy. This ’meta-reasoning’ on where to place the stopping threshold has been shown to depend on past experience and resource availability (Lieder & Griffiths, 2017; Jagga et al., 2021). Both OSPs and meta-reasoning approaches are based on carefully curated laboratory tasks. They capiltalize on accurate predictive models while compromising on ecological validity.

Stopping decisions are also intimately involved in quitting decisions. Quitting is defined as completely stopping an activity that a person would like to continue. In order to investigatequitting behaviors, we wanted to step beyond laboratory constraints.

Online chess serves as a naturalistic context where features from chess tournaments are replicated in a competitive digital space. Quitting a chess match holds actual consequences for a player by affecting their rankings/ratings. Each player has an associated ELO rating that defines their skill level that responds to a player’s wins and losses. We used chess as a testbed for understanding quitting due to its constraint on sequential decision making and being ecologically relevant.

Methods

Data Pre-processing

We extracted 1 million chess games from the chess server *lichess.org*. We randomly selected players (N_{total}=13,000) whose matches were fed into a chess engine *(Stockfish v10)* that performs a move-by-move analysis of each game and assigns a numerical value for each move signifying its advantage w.r.t to the white player. The engine also outputs a binary value for the final move as either signifying a checkmate or not. Only ’Normal’ termination games i.e. those ending either due to a checkmate or resignation are included.

Resign games are assigned at the level of the player. Games where the final move is not a checkmate and the game result indicates a win for the opponent are classified as a resign game for the player. We selected players (N_{resign}=600) that had at least 1 resigned game in their roster for further analysis.

Data analysis

We were interested in defining a playerlevel psychological variable that predicts their propensity to quit chess matches. Within chess, we defined quitting as the rate at which a player resigns matches across their roster (called ’quit rate’). We assumed that the move numbers for each game represent a discrete unit within which players think about their next move and each move represents the current status of losing the game w.r.t to the player.

Quit rate (QR) is operationalized as the hazard rate calculated as probability of the eventof-interest (i.e. resign) taking place at the next move given survival until this move. In order to model QR, two types of mixed-effect hazard regression models are formulated. The first model ('conditional model') considers only resign games from each player's roster: QR_{resign} " exppβ1V_1`β2$V_2$`...`β$nV_n$` 1|*player*q. The second model ('unconditional model') considers the complete roster for each player: QR_{all} " exppβ$_1V_1$`β$_2V_2$`...` β$_nV_n$` 1|*player*q. Here, fixed effects refer to various game factors that affect QR while random-effects refer to the players identified by player ID.

Results

We selected covariates that have had relevance for predicting and assessing human chess performance such as player ELO ratings (*playerElo*), difference in ELO ratings between player and opponent (*eloDiff*), and evaluation of last move (*playerElo*). To assess the influence of prior quitting attempts on the current game, a binary quit variable (*pastQuit1*) was created.

For the conditional model (Table 1), playerElo and eloDiff had negative and positive relations with QR, respectively. playerElo x eloDiff interacted positively with quit rate. In terms of effect sizes, playerElo (*exp*pβq=0.81) and eloDiff (*exp*pβq=1.06) predict a 19% and a 6% reduction in QR, respectively.

For the unconditional model (Table 2), eloDiff and playerElo x eloDiff are negatively related to QR. Having quit in the past match (pastQuit1) showed a positive relation with QR. In effect sizes, eloDiff (*exp*pβq=0.73) and playerElo x eloDiff (*exp*pβq=0.94) and predict a 27% and a 6% reduction in QR, respectively. Meanwhile, pastQuit1 (*exp*pβq=1.02) predicted a 2% reduction in QR.

Discussion

Historically, chess has been studied w.r.t human problem solving Wagner & Scurrah (1971). Inspired from that, chess served as a testing ground to understand how humans decide to 'call it quits'. We operationalized quitting as a rate variable that delineates this psychological process. We focused our efforts on understanding how game related factors affect this quitting rate.

Using chess players' resign games to characterise their quitting behavior we validated an intuitive concept in chess, a player is more likely to quit when they are at a skill disadvantage compared to the opponent.

Covariate	β	95% CI	p-value
Eval	0.01	0.00,0.02	0.2
playerElo	-0.21	-0.23,-0.18	<0.001
eloDiff	0.06	0.04,0.08	<0.001
playerElo x eloDiff	0.02	0.01,0.04	<0.001

Table 1: Conditional model with only resign games for each player. CI = Confidence Interval.

Covariate	β	95% CI	p-value
Eval	-0.01	-0.02,0.00	0.051
playerElo	-0.09	-0.12,-0.06	<0.001
eloDiff	-0.32	-0.34,-0.30	<0.001
pastQuit1	0.02	0.01,0.04	0.003
playerElo x eloDiff	-0.06	-0.08,-0.04	<0.001

Table 2: Unconditional model with all games for each player. CI = Confidence Interval.

However, when the full roster (wins/losses/resigns) is considered, players seem less likely to quit when faced by a tougher opponent. A possible explanation would be that players select for a persistence strategy that allows them to learn newer skills from a highly skilled opponent, even if they end up losing the match. This could represent a rational metacognitive solution to the problem of deciding to resign Callaway et al. (2018).

We also found that a recent experience of quitting in the previous game positively impacted one's chances at quitting in the current match. Having lost in the previous match can increase the probability of resigning in the current match. This informs us that people's quitting experiences in online games leaves a momentarily significant mark on their future gaming experience.

Our analysis has relevance for both chess players and researchers interested in studying quitting. Unlike previous models of the closely related stopping decisions, our analysis of quitting in chess provides an ecologically valid context where humans use rational strategies in order to decide on the 'right time' to quit.

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Talk Session 8: Cognition and Applications

Exploring the Role of Cognitive Empathy in Shaping Universalism-Based Human Values: A Gender-Driven Analysis

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Introduction

Human values in universalism embody the principles of tolerance, concern, and acceptance, standing out as a cornerstone for fostering emphasis on collective well-being. Daniel Batson's empathy-altruism hypothesis laid the foundation for the link between trait empathy and human values (Batson et a1., 1981). However, the distinct impact of cognitive empathy on human values remains an unexplored area in the Indian cultural context. This study delves into the possible links between cognitive empathy, which is characterised by its capacity to understand others' viewpoints, and its predictive power on universalism values in particular. Furthermore, recognizing the significance of understanding potential gender differences in this context offers insights into how gender modulates the relationship between cognitive empathy and universalism. By probing these connections, this research contributes to the theoretical understanding of empathy's role in shaping values and sheds light on the gender-specific dynamics that influence these associations.

Methods

The study involved 580 participants (291 females, 289 males), with English proficiency, including only Indian university students. The examination was approved by the Institute Ethics Committee of the Indian Institute of Technology, Delhi. (IEC-IITD; Proposal No. P021/P0101). Cognitive empathy, consisting of the sub-scales of fantasy and perspective-taking, was measured using the self-report assessment of the Interpersonal Reactivity Index (IRI; Davis, 1980), whereas the Big Five Inventory (Goldberg, 1993; BFI) was used to assess personality factors. Cronbach's alpha was calculated to be 0.702 for cognitive empathy; 0.719 and 0.619 for the sub-scales of fantasy and perspective-taking, respectively. The universalism values were assessed employing the revised Portrait Values Questionnaire (PVQ-RR, Schwartz et a1., 2012). The nineteen refined Schwartz's values also displayed satisfactory inter-item reliability (<Mean ' 0•656# SD' 0.111). Statistical analyses, including zero-order correlation, linear regression, and hierarchical regression, were performed on Jamovi (The Jamovi Project, 2023). A two-staged hierarchical regression model was further employed, supplementing the previous analyses to examine cognitive empathy's unique contribution beyond personality traits in endorsing universalism values. Moreover, Bonferroni corrections adjusted the significance value to 'p = .003', accounting for nineteen comparisons.

Results

The findings suggested that the value of universalism was significantly and positively correlated with cognitive empathy, notably with the component of perspective-taking in bothfemales (r = .301# Padj < •003) and males (r = .327, pp, < .003). This relationship was further explored by breaking down universalism into three types, i.e., universalism-nature, universalism-concern, and universalism-tolerance. Linear regression analysis revealed that perspective-taking positively predicted universalism-concern in females (§ = .164, Padj < .003) and universalism-tolerance in males (§ = .285# Padj < •003). In neither of the groups, universalism-nature correlated with cognitive empathy.

Hierarchical regression analysis found gender differences in the percentages of variance in universalism values explained by cognitive empathy after controlling for BFI personality traits. In females, cognitive empathy explained 3.46% of the variance of universalism-concern values, whereas in males, cognitive empathy explained 5.98% of universalism tolerance values. Besides, in both gender groups, perspective-taking positively contributed to this relationship in a significant manner and not fantasy. This finding highlights the crucial role of the perspective-taking component of cognitive empathy that contributes to the distinctive prediction of these

values beyond personality factors.

Discussion

The results underscore the complex role of cognitive empathy in shaping and understanding the endorsement of different values of universalism in females and males. The value of universalism-concern can be understood as the commitment to equality, justice, and protection for all people (McQuilkin et al., 2016). Cognitive empathy positively influences females' universalism-concern values, with higher levels promoting welfare and social justice, while males' higher levels promote acceptance and understanding of those different from themselves. These findings can be understood through gender-specific roles and socialization in the Indian context. The social role theory (Eagly, 1987) posits that distinct societal expectations and roles lead men and women to experience different rewards and costs for the same behavior, which results in them adopting different beliefs and values based on their social roles. Eagly et a1. (2000) observed that women are expected to engage in social roles that prioritize others, such as nurturers, caregivers, and transmitters of moral values within the family unit. Besides, the findings also suggest that while cognitive empathy helps increase empathy-driven behavior, it may not necessarily encourage values involving broader social goals such as social justice. Men enjoy greater freedom in gender and social hierarchy and are expected to prioritize personal goals over social goals (Vilar et a1., 2020). The absence of a significant relationship between cognitive empathy and universalism-nature indicates that there are other traits that might operate independently of cognitive empathy, such as ecological awareness in the development of such environment-related values. In conclusion, this Indian sample highlights the distinct role of cognitive empathy in shaping universalism values and the unique contribution played by gender socialization processes.

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Quality of Sleep, Stress and Academic performance among University Students during Covid-19 pandemic

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Introduction

The COVID-19 pandemic has profoundly disrupted various aspects of life, causing significant physical, psychological, and social impacts on individuals. Among those most affected are higher education students, who have experienced unprecedented levels of stress and anxiety. Data indicate that nearly half of American college students seeking mental health treatment struggle with anxiety, depression, or stress, and the pandemic has only exacerbated these issues (American College Health Association, 2019). This heightened stress has threatened students' mental well-being and is linked to poor sleep quality, a crucial factor for cognitive function and overall health. Sleep deprivation is known to impair concentration, memory, and academic performance, making the interplay between stress and sleep particularly concerning for students aiming to excel academically during this challenging period (Robillard et al., 2021).

Research consistently underscores a strong correlation between stress, poor sleep quality, and academic difficulties, particularly among medical and nursing students who face significant pressure (Vogel et al., 2020). The pandemic has intensified these issues, disrupting students' sleep patterns and increasing their stress levels, which in turn has further impaired their academic performance (Achterberg et al., 2021). Stress impacts not only mental health but also physical well-being and academic outcomes. Despite the clear connections between stress, sleep deprivation, and student performance, limited research has explored how these factors interact, especially within the context of the pandemic.

This study aimed to investigate the relationship between sleep quality, stress, and academic performance among university students during the COVID-19 pandemic, focusing on how these factors interact and influence each other during this difficult time.

Methodology

A cross-sectional study design was employed, examining the relationships among 201 university students (97 females, 103 males, and 1 other), aged 18 and above, selected through purposive sampling from various academic disciplines.

The study utilized two standardized scales: the Pittsburgh Sleep Quality Index (PSQI), which measures sleep habits with scores ranging from 0 (no difficulty) to 21 (high difficulty), and the Perceived Stress Scale related to COVID-19 (PSS-10-c), which assesses pandemic-related stress on a 5-point Likert scale (Cronbach’s alpha = 0.86) (Buysse et al., 1989; Cohen et al., 2020). Additionally, demographic data such as age, gender, institution, and GPA were collected.

The collected data were analyzed using R programming, specifically version 4.0.4.

Results

The data analysis incorporated descriptive statistics, Pearson’s correlation, and mediation analysis to examine the relationships among the variables. Descriptive statistics revealed that the mean academic performance score among participants was 8.15 (SD = 1.10), the mean PSQI score was 6.97 (SD = 2.90), and the mean stress score was 15.05 (SD = 6.76). Correlation analysis found that sleep quality, as measured by the PSQI, was negatively correlated with academic performance ($r = -0.19$, $p < .01$), indicating that better sleep quality is associated with improved academic outcomes. Stress showed a non-significant negative correlation with academic performance ($r = -0.064$). Additionally, a positive correlation was observed between stress and PSQI ($r = 0.282$, $p < .001$), suggesting that higher stress levels are linked to poorer sleep quality.

Mediation analysis revealed that stress did not directly predict academic performance ($B = 0.002$, $p = 0.866$). However, stress predicted poorer sleep quality ($B = 0.121$, $p < .001$), which

subsequently had a negative impact on academic performance (B = -0.071, p < .005). The indirect effect of stress on academic performance, mediated by sleep quality, was statistically significant (z = -2.14, p < .05). These results support the hypothesis that there is a relationship between stress, sleep quality, and academic performance. Specifically, the study found a negative correlation between sleep quality and academic performance, consistent with previous research that highlights the importance of adequate sleep for cognitive functions such as memory and attention (Walker, 2017).

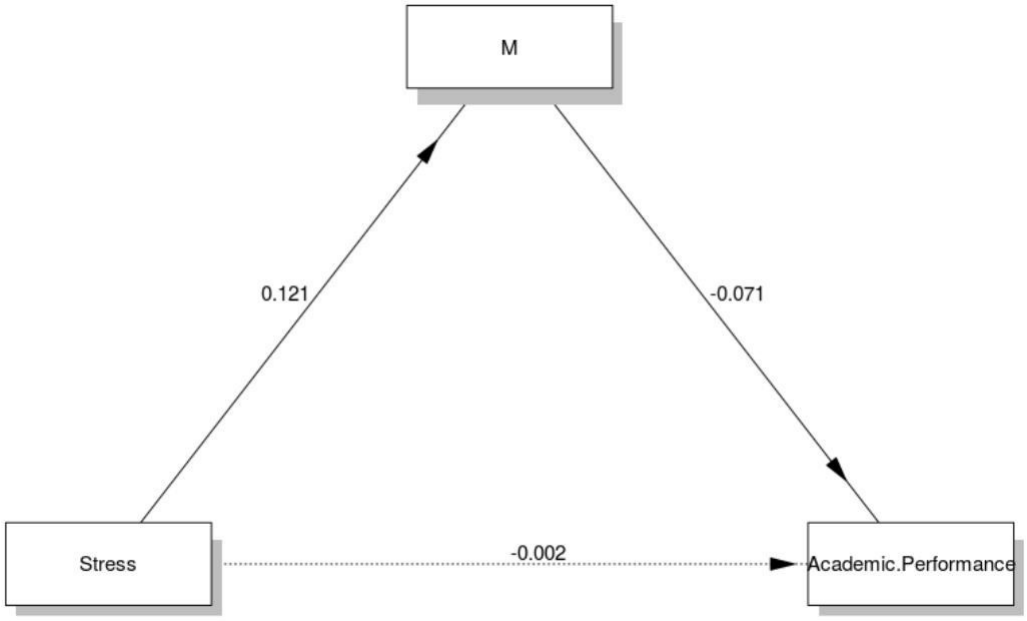

Figure1: The statistical diagram of mediation analysis

Discussion

The finding that stress did not have a significant direct effect on academic performance might be attributed to factors like the study's sample size or individual differences in coping mechanisms. However, when considering sleep quality as a mediator, stress was found to have an indirect impact on academic performance, emphasizing the importance of good sleep in managing stress and enhancing academic outcomes. Additionally, the study found that stress was positively correlated with poor sleep quality, which aligns with prior research linking high stress levels to sleep disturbances (Gordon et al., 2019). This suggests that interventions targeting sleep quality could help mitigate the negative effects of stress on academic performance.

The study's findings are limited by the relatively small sample size, which may affect the generalizability of the results. Future research should explore these relationships in larger, more diverse populations. Additionally, developing interventions aimed at improving sleep quality could support academic performance among students experiencing high levels of stress.

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Talk Session 9: Emotion & Cognition

Emotion Can Fool Your Perception but Not Action: Differential Effect of Emotion on Perception vs Action Task

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Introduction

Early theories of emotions, such as those proposed by William James, suggest that bodily changes precede emotions, which then lead to actions. In contrast, modern theories like the New Basic Emotion Theory (BET) argue that emotions are action tendencies that prompt various responses based on situational demands (Scarantino, 2017). While the interaction between emotions and perception is well studied, the effect of emotions on motor actions is not well documented. Recent research by Lu et al. (2021) found that emotional distractors significantly impact cognitive-motor performance: negative stimuli reduce accuracy in simpler movements, while positive stimuli enhance precision in more complex tasks. Additionally, Moher et al. (2015) showed that perceptually salient distractors affect target performance in perception-based tasks but don't impact goal-directed actions. This finding suggests a salience-triggered suppression mechanism that improves efficiency and accuracy in target selection during goal-directed actions. However, whether this perception-action distinction applies only to perceptually salient distractors or also extends to emotional distractors remains to be tested. Building on these findings, the present study examines emotional distraction in both perception- and action-based tasks. It hypothesizes that the suppression of highly salient emotional distractors will be more pronounced in action-based tasks than in perception-based tasks.

Methodology

This study was conducted on University students (n = 30). This study used the additional singleton paradigm. In each trial, participants were presented with a target among distractors, where one distractor (an emotional image) was more salient than others. The experiment was made on PsychoPy software, with stimuli sourced from the International Affective Picture System (IAPS; Lang et al., 2005). The task was divided into two phases: the action phase and the perception phase. In the action phase, participants performed a reaching task using a stylus, while in the perception phase, they engaged in a key press task using a wireless keyboard to identify the presence or absence of a target.

Data Analysis

Data from the perception and action phases were analyzed separately. For the perception phase, reaction time (RT) analysis was conducted to assess the impact of emotional distractors on target perception. In the action phase, RT, Root Mean Square Error (RMSE), Area Under Curve (AUC), and Peak Velocity (PV) were measured to evaluate the influence of emotional distractors on motor actions. Repeated measures ANOVA was used to analyze the data, with separate analyses for target-present and target-absent trials. Due to the text limit, we have focused on discussing the effects rather than providing specific statistical values.

Results and discussion

The findings reveal significant effects of phase (action vs. perception), target presence, and emotional valence (neutral, positive, negative) on reaction times (RTs). Specifically, RTs were significantly faster in the action phase compared to the perception phase. This supports the idea that emotional distractors are more disruptive in perceptual tasks than in motor tasks, potentially due to different cognitive demands and the engagement of differential perceptual pathways (ventral vs dorsal stream).

Further, the RMSE results indicated that motor errors were significantly lower in the negative distractor compared to the positive or neutral distractor conditions. This suggests that negative emotions might enhance motor precision by narrowing attention and improving

focus, consistent with previous research indicating that negative emotions can heighten arousal and cognitive control, thereby enhancing task performance (Finucane, 2011).

The AUC analysis showed that participants' motor trajectories were significantly influenced by emotional valence. Participants exhibited more direct and efficient movement paths when responding to negative stimuli, as evidenced by a lower AUC. This suggests that participants were motivated to reach the target more quickly and efficiently, possibly to minimize exposure to aversive stimuli. In contrast, positive stimuli led to more exploratory movements, resulting in a higher AUC. These findings align with theories of threat processing, which propose that negative stimuli prompt more goal-directed and efficient behaviour (Kim et al., 2020).

Furthermore, PV was significantly higher in the target-present condition across all emotional valences, indicating that participants moved faster when they had a clear goal. However, the presence of negative stimuli in the absence of a target led to a significant decrease in peak velocity, suggesting that negative emotions slow down movement in ambiguous or uncertain contexts. This may be due to increased cognitive load or hesitation, as participants might be more cautious when responding to aversive stimuli without a clear target (Schwabe & Wolf, 2011).

The differential effects of emotional valence on RT, RMSE, AUC, and PV suggest that emotions can both enhance and impair motor performance depending on the context and task demands. Negative emotions, in particular, appear to enhance motor precision and efficiency through increased cognitive control and attentional focus. These insights could have applications in fields such as rehabilitation, where understanding how emotions influence motor behaviour could improve therapeutic outcomes.

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Emotions in Spatial Representation: Interaction of Valence and Arousal in Route and Survey Knowledge

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Introduction

The emotional value of landmarks is a critical component that can potentially influence spatial memory (Nuhn & Timpf, 2017). Individuals develop emotional connections to specific places based on their past experiences in these places. It is thus worth exploring how emotional connections to landmarks can influence one's spatial memory about the landmark's location. Valence and arousal are two dimensions of any emotion. Applied to a navigational context, the valence of emotion (positive or negative) informs the observer of the emotional value of the landmark, whereas the arousal (high/excited or low/calm) informs the observer of the urgency or immediacy of the intended action. The present study investigates the potential role of valence and arousal of emotional landmarks on both route knowledge (sequence of turns from the navigator's perspective) and survey knowledge (bird's eye view of the layout transcending the navigator's view). Suppose specific levels of valence and arousal can enhance route and survey knowledge. In that case, the results can support the formulation of interventions aiming to rehabilitate patients with depression (which is accompanied by Anhedonia) and Topographical Disorientation (Bianchini et al., 2010).

Methods

Emotional images were selected from the Open Affective Standardized Images Set (OASIS). A standardisation study was conducted in the Indian context in which 50 participants were asked to rate each image on valence and arousal on a 5-point scale. Based on this pretesting, 5 images each were selected for each group: positive valence-low arousal (PVLA), positive valence-high arousal (PVHA), negative valence-low arousal (NVLA), negative valence-high arousal (NVHA). 6 neutral images were also selected. A 3-minute video was recorded where a rider drove a vehicle through a route with 11 intersections. The video was edited to add emotional images at every intersection. Every emotional image was alternated with a neutral image to ensure ecological validity. A total of 4 videos were created for each group. The route remained the same across all 4 groups but only differed in the emotional images added at the intersections.

The study included 53 participants aged between 18-28. Each participant was randomly allocated to either of the four groups (PVLA, PVHA, NVLA and NVHA) and viewed the video corresponding to their group. Participants then responded to two tasks: the direction recall task (DRT), which measured route knowledge and the distance comparison task (DCT), which measured survey knowledge. Both tasks were scored. The analysis was conducted using Jamovi.

The data collection is still in process, and the analysis is based on the data already collected.

Results and Discussion

A Fisher's one-way ANOVA showed no significant effect of group on route knowledge, $F(3,48) = 0.29, p = 0.83$. However, there was a significant effect of the group on survey knowledge, $F(3,48) = 2.85, p = 0.04, \eta_p^2 = 0.151$ indicating a large effect. Tukey's post hoc tests revealed a significant difference between the survey knowledge performance of PVHA and PVLA groups, $t = 2.786, p_{tukey} = 0.03$, Cohen's $d = 1.07$ indicating a large effect.

A two-way ANOVA was conducted to investigate the interaction effects of valence and arousal on survey knowledge performance. The overall model was significant ($F = 3.11, p = 0.035$). There was no significant main effect of valence ($F = 1.38, p = 0.24$). However, arousal significantly affected ($F = 4.14, p = 0.047$) survey knowledge performance, with $n_p^2 = 0.07$ indicating a medium effect. Tukey's post hoc tests showed there was a significant difference due to arousal, $p = 0.047$, and Cohen's $d = 0.56$, indicating a medium effect of the difference between low and high arousal groups. This meant that participants in the high-arousal groups scored higher than those in the low-arousal groups, irrespective of valence. The interaction effect (valence*arousal) showed a trend towards significance ($F = 3.46$,

p=0.06). Tukey's post hoc analysis for the interaction showed that there was a significant difference between PVHA and PVLA, *MD=0.93, t=2.86,* p_{tukey}*=0.30*, *Cohen's d = 1.08* indicating a large effect size.

In summary, the results show that there is a significant large effect of group on survey knowledge performance and not on route knowledge. There is also a significant medium-sized effect of arousal on survey knowledge performance. Participants in the high arousal conditions performed significantly better than those in the low arousal conditions, irrespective of valence on the distance comparison task. Both valence and arousal do not interact to affect route and survey knowledge except in one condition where positive valence and high arousal interact to enhance survey knowledge performance even though there is no significant main effect of valence.
The results indicate emotional landmarks may not determine one's route knowledge.
However, they can determine one's survey knowledge of the route, with higher levels of arousal elicited by the landmarks aiding better memory of the layout when paired with positive valence.
The results align with findings that showed that positive valence aided better allocentric memory (Palmiero & Piccardi, 2017; Ruotolo et al., 2021). Further studies that included arousal also showed no effect of valence on survey knowledge; instead, high arousal aided performance on survey knowledge (Ruotolo et al., 2021).

The neuropsychological theory of positive affect (Ashby et al., 1999) indicates that positive affect influences performance on many cognitive functions like working memory and episodic memory consolidation due to increased dopamine levels in the brain. In context, landmarks with a positive emotional value could play a better role in consolidating the route when they are highly arousing. This theory is conceptually similar to the Broaden and Build Theory (Frederickson, 2001), which states that positive emotions expand our thought-action repertoires and can effectively improve one's personal and psychological resources, including creativity and intellectual abilities. One can extrapolate from this theory that since positive emotions serve an adaptive function, positive emotional landmarks can aid better spatial memory, given that they are paired with high arousal.

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POSTERS
Session 1

Memory of Emotional Events Under Cognitive Load Influence Resting State Functional Brain Connectivity in Subclinical Anxiety

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Introduction

Memory suppression is an active process that voluntarily prevents the intrusion of undesirable memories into one's conscious awareness [1]. However, the process may trigger ironic effects, meaning such supressed memories become more accessible to the conscious mind. Cognitive load is one of the factors contributing to ironic effects [2]. The influence of directed remembering and suppression of emotionally valenced memories under cognitive load in anxiety are sparse in the literature, to our knowledge. We, therefore, measured whether the directed remembering/recall or suppression of emotionally valenced memories impact an independent visual working memory task (imposing a cognitive load) in healthy young adults (n = 37) with dispositional/subclinical anxiety. We employed a quantitative behavioural experiment of "item-method-directed forgetting" followed by another experiment to ensure task compliance and a separate functional magnetic resonance imaging experiment involving resting-state functional brain connectivity (rsfc) towards this end. Thus, each participant performed three experiments. The behavioural results obtained using BIS (Balance Integration Scores) metric revealed that participants performed worse in the task imposing cognitive load with emotionally valenced (Negative and Positive) memories vs. Neutral, suggesting greater intrusion from such memories. Further, in the low-anxiety subset, task performance enhanced with relative anxiety severity while recalling Negative memories. In a separate analysis, the rsfc between Anterior Cingulate Cortex (ACC) – Precuneus correlated significantly with the BIS of the task imposing cognitive load in Positive memories. Here negative correlation between the aforementioned brain regions was found under directed memory suppression. Furthermore, an anxiety x rsfc interaction was evident under Positive memory suppression towards explaining the BIS of the independent cognitive task.

Methods

We recruited 37 participants (11 females; age= 21. 2 ± 2.2 mean ± SD) who completed the National Institutes of Health (NIH) toolbox fear affect (FA) scale - a proxy measure of anxiety. Greater scores on the scale imply greater dispositional / trait anxiety (cognitive component) and ranges between 32 - 75. The median FA score in our sample was 48 with interquartile range = 16. Each participant completed a behavioural experiment spanning 1.5 hours on Day 1 and a magnetic resonance imaging (MRI) experiment involving a structural T1-weighted imaging + eyes-open, task-free, functional T2*-weighted blood-oxygen level dependent (BOLD) imaging of the brain spanning 30 minutes on Day 2. The task required participants to either remember ('Think') or suppress ('No-think') the presented stimulus (Positive/Negative/Neutral image) followed by an independent visual working memory (cognitive) task. At the end, a recognition task followed for ensuring task compliance. From the accuracy and reaction time measures obtained, we calculated a composite metric - Balanced Integration Scores (BIS) after subtracting the reaction time (z score) from accuracy (z score), which was used in further analyses. To assess the influence of anxiety and emotional memory suppression/recall efficiency on task performance, we split the participants by the median scores (48) into high (> 48) and low fear-affect groups (≤ 48). The

BIS of these two groups were correlated with fear affect scores. Furthermore, to investigate the association between BIS and rsfc, we performed multiple linear regression analyses on CONN toolbox [3], a MATLAB-based software. To identify salient effects, the following statistical thresholds were used - a threshold of $p < 0.05$ for the behavioural results; an initial whole-brain voxel-level threshold of $p < 0.001$ followed by an additional stringent cluster level threshold of $p < 0.05$ after correcting for family-wise error rate (FWE) for the rsfc results.

Results

The behavioural results revealed that under the cognitive load imposed by the working memory task, participants performed worse while suppressing Negative and Positive emotional memories vs. Neutral (all *t*s < -2.59, Bonferroni-corrected *p*s< 0.04). This suggests a greater intrusion from Negative and Positive memories compromising the task performance vs. Neutral. Further, in the low-anxiety subset (n = 20) from the above sample, the task efficiency enhanced with increasing anxiety severity while recalling Negative memories (*Pearson's r* = 0.48, $p = 0.03$; Figure:1a). Separately, the rsfc between Anterior Cingulate Cortex (ACC) – Precuneus (Figure 1b) scaled significantly with the suppression efficiency of Positive memories regardless of age and gender. Specifically, a negative trend in rsfc was seen with decreasing task efficiency in suppressing Positive memories (Figure: 1b) and anxiety moderated this trend. (all *t*s < -5.21, # *voxels* ≥ 365, *pFWE*s < 0.002).

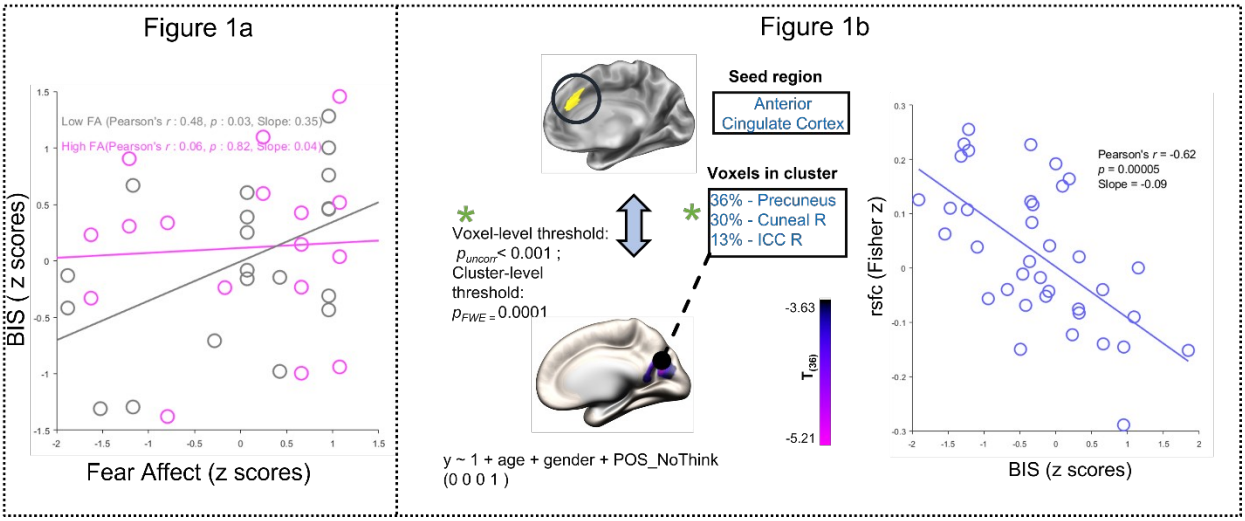

Figure 1a: Relationship between anxiety severity (Fear-affect z-scores) and BIS z-scores visualised as different trends in low and high-anxiety subset. **1b:** Connectivity of ACC with Precuneus cluster for suppression of Positive memories - statistical maps on brain surface (left panel) and extracted data visualised as scatter plot (right panel).

Discussion

We investigated the efficiency of memory recall and suppression of emotional stimuli in anxiety under independent cognitive load, neurobehaviourally. We found that emotionally valenced memories are more challenging to suppress as reflected by the compromised cognitive efficiency in the task. Of the above, notably, we found differential brain

connectivity between two hubs of the salience and default mode networks, respectively—the ACC (involved in cognitive control) and the Precuneus (involved in self-referential episodic memories)—specifically during the suppression of positive memories [4-5], which was further moderated by relative anxiety severity. The results explain the interplay of emotions, anxiety and memory under cognitive load, which is of relevance to better understand the dynamics of memory suppression in affective traits and disorders.

Effect of Mind Wandering and Framing on Risky Decision-Making: An Experimental Investigation

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Introduction

Mind-wandering (MW) is a phenomenon where attention shifts from a primary task to selfgenerated thoughts and is a common aspect of human cognition. Antrobus et al., (1966) defined MW as stimulus-independent thoughts. MW is categorised into two types: Deliberate MW is associated with higher meta-awareness and the ability to redirect attention, whereas spontaneous MW often correlates with attentional control failures and various psychological traits like ADHD and OCD (Seli et al., 2015, 2017).

Research suggests that individuals spend 30-50% of their waking hours in MW (Kane et al., 2017; Killingsworth & Gilbert, 2010), which can negatively affect performance in tasks requiring sustained attention, such as reading and decision-making. MW has been linked to impaired executive control and decision-making efficiency (Smallwood et al., 2013). Additionally, the framing effect, where individuals respond differently to the same problem based on its presentation (gain or loss framing), influences risky decision-making (Kahneman & Tversky, 2013). This study investigates how state and trait levels of MW and framing effects influence risky decision-making.

Method

The study involved 39 participants from a technical institute in India, with an average age of 24.8 years. Participants completed a risky choice task of 300 trials, choosing between sure and risky monetary options. The task was divided into two blocks of 150 trials, with break and practice trials. MW was measured intermittently using thought probes, and participants completed the Mind-wandering questionnaire to assess trait levels of spontaneous and deliberate MW (Carriere et al., 2013). Data analysis involved classifying trials as on-task or MW episodes based on probe responses and computing the proportion of risky choices. A repeated measure ANCOVA was conducted to examine the effects of state MW, framing, and trait MW on risky decision-making.

Results & Discussion

Descriptive statistics showed that participants made more risky choices during on-task episodes than MW episodes. Our results found a significant effect of state MW and the interaction of deliberate MW with state MW on risky decision-making. Deliberate MW also had a significant impact, indicating that trait deliberate MW moderated the effect of state MW on risky choices. Further analysis of estimated marginal means showed that the effect of state MW on risky choices was significant only at low levels of trait deliberate MW. The effect was insignificant at medium and high levels of trait deliberate MW. This suggests that individuals with low levels of deliberate MW are more influenced by state MW, leading to fewer risky choices. The findings suggest that state MW leads to a preference for safer options, aligning with the resource depletion theory, which posits that MW consumes cognitive resources, leaving fewer resources for evaluating risky choices (Thomson et al., 2015). The interaction between state MW and trait deliberate MW highlights the importance of individual differences in MW tendencies. Individuals with high trait deliberate MW can better manage their attention and are less affected by state MW, supporting the meta-awareness hypothesis (Smallwood, 2013).

The framing effect on risky decision-making was insignificant. The lack of a significant framing effect contradicts classic findings on risky decision-making (Kahneman & Tversky, 2013). The framing effect is also magnitude-dependent; people tend to weigh losses more highly than gains at greater magnitudes, a pattern not seen at lower magnitudes (Mukherjee et al., 2017). Our findings are consistent with this study since we did not discover a framing

impact on risky decisions at different magnitudes. The choice of low-magnitude monetary values in our study may have contributed to this lack of significance since it may not have adequately captured the influence of framing on decision-making in various settings.

Conclusion

The findings have implications for decision-making research, particularly in contexts where MW is prevalent. Future research should explore the effects of MW and framing in diverse decision-making scenarios to generalise the results. Additionally, methodological improvements, such as measuring spontaneous and deliberate MW at state levels, could enhance the robustness of findings.

Perception of experience influences altruism and perception of agency influences trust in human-machine interactions

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Abstract

It has been argued that minds are perceived along two dimensions: *experience*, i.e., the ability to feel, and *agency*, i.e., the ability to act and take responsibility for one's actions. Here, we pair participants with bots in a dictator game (to measure altruism) and a trust game (to measure trust) while varying the bots' perceived experience and agency. Results demonstrate that the perception of experience influences altruism, while the perception of agency influences trust.

Introduction

The seminal work of Gray et al. (2007) demonstrated that people perceive the minds of others along two dimensions: (i) *experience*, i.e., the capacity to feel emotions; and (ii) *agency*, i.e., the capacity to plan and act. Despite numerous studies examining the perception of agency and experience, the role that these two dimensions play in altruism and trust is unknown. We hypothesize that the perception of experience in an interaction partner predicts acting altruistically towards them. This is motivated by previous findings that altruism is influenced by empathy (Klimecki 2016) which, in turn, is associated with the ability to perceive the emotional states of others (Batson 2002). Another hypothesis we put forward is that the perception of agency in an interaction partner predicts trust towards them. This idea is rooted in the fact that trust hinges on evaluating an individual's capacity to reciprocate which, in turn, relies on assessing their ability to plan and take action (Barney 1994).

To test these hypotheses, we need to measure people's altruism and trust towards machines while varying the machine's perceived experience and agency. To this end, we employ two canonical games: a one-shot Dictator Game (DG) and a one-shot Trust Game (TG). The amount shared in DG serves as a proxy measure for altruism and prosocial behavior, while the amount shared in TG reflects the allocator's assessment of the receiver's trustworthiness. We paired 150 participants with bot partners in DG and TG while manipulating the bot's experience by writing ``*This robot is [capable / not capable] of feeling pain*", and manipulating the bot's agency by writing: ``*This robot is [capable / not capable] of planning actions and exercising self-control.*".

Results

As can be seen in Figure 1a, participants act more altruistically toward bots that are described as having experience, regardless of whether they have agency. These findings provide causal evidence that the perception of experience influences altruism. Similarly, as shown in Figure 1b, participants show greater trust in bots that are described as having agency, regardless of whether these bots have experience. These findings provide causal evidence that the perception of agency influences trust.

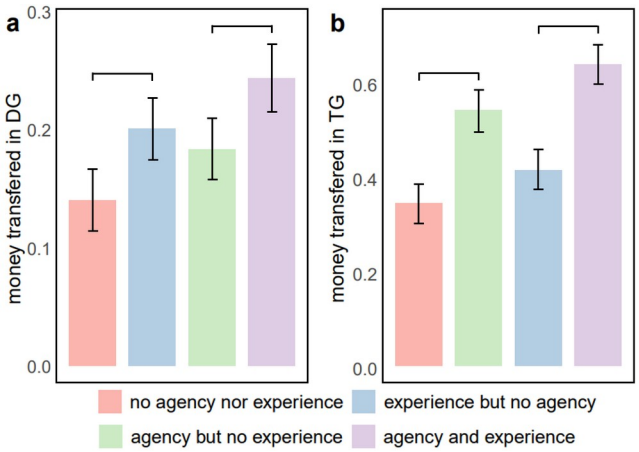

Figure 1: Money transferred in DG and TG.

A Novel BCI Classifier for Classification of Multi-Class Motor Imagery Data

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Abstract

Motor Imagery Brain-Computer Interface (MI-BCI) is gaining prominence due to its robust and intuitive commands. Even within this area of research, the systems that can identify movements within the upper limb provide more promising research. This research proposes a novel Brain-Computer Interface (BCI) system for classifying such signals. The system utilises task-related component analysis (TRCA) to extract spatial and temporal features from EEG data, showing brain activity during visualising motor movements. This model achieves higher accuracy than existing methods, especially for hand movement. This improvement is attributed to the richer feature set captured by TRCA. The findings also suggest the potential for accurate finger movement identification and exploring movement vividness through observed parietal activation. These advancements promise to develop more precise and versatile BCIs for rehabilitation, prosthetics, and virtual reality applications.

Introduction

A Brain-Computer or Brain-Machine Interface is defined as a system that translates human brain activity into commands that are used by an interactive application to perform a set of tasks (Lotte et al., 2018). The BCI system performs this function in five consecutive steps – Signal acquisition (Detecting brain activity with the help of sensors), preprocessing (Removing noise out of the signal), feature extraction (Extracting feature vectors of the signal that can help in identifying events), classification (Identifying the signal and classifying it in categories) and control interface (Application which converts the outputs of classifiers into a set of commands for an external application like computers or wheelchair) (Nicolas-Alonso et al., 2012). In these steps, the feature extraction and classification steps are crucial for working with any BCI system.

Most common BCI systems, both experimental and commercial, commonly use the P300 evoked potential to control the machine (Mak et al., 2011). P300 is a component of an event-related potential (ERP) that is seen 300 milliseconds after the stimuli are given (Fazel-Rezai et al., 2012). Due to its simple and predictable nature, Systems based on P300 components are among the most accurate systems (Fazel-Rezai et al., 2012). However, the P300 evoked potential signal conveys limited information and offers limited control options. A signal that offers more robust and intuitive control is the motor imagery signal. This unique advantage of motor imagery signals offers various applications ranging from controlling prosthetics and robotic limbs to navigating in virtual reality (Saha et al., 2021). Better feature extraction and classification methods must be researched to make motor imagery signals more efficient to read (Ahn & Jun, 2015). More common Motor Imagery BCI studies focus on between-limb classification with the help of features extracted by methods like CSP (Common Spatial Patterns), e.g. Right Arm vs Left Arm, Leg Vs. Arm, the models based on PhysionNetMI and BCI – III datasets are the most accurate models in MI-BCI (Altaheri et al., 2021). However, the between-limb approach offers a limited set of commands. Hence, research in within-limb accuracy is needed to make more robust BCI models for better real-time post-stroke rehabilitation and commercial application. Research in Within-Limb Motor-Imagery BCI is more focused on increasing the accuracy of Motor-Imagery BCI by building better feature extraction and classification methods.

One of the first models for within-limb classification was done by Ofner et al. (2017), where they acquired and classified the signal related to elbow, forearm and hand movement in the

right arm using LDA. However, this model was not as accurate for the imagination of motor movement (27% for movement-vs-movement, 65% for movement-vs-rest) as it was for motor execution (42% for movement-vs-movement, 81% for movement-vs-rest). The recent advancement in this direction was made by Jia et al. (2023), whose feature extraction method, A spatial filter based on TRCA followed by feature extraction by CCA, claims to be an accurate classification system (Jia et al., 2023). However, their classification method is less accurate in classifying some classes' signals. Hence, a feature extraction method is required to classify all upper limb movements accurately and consistently.

This paper proposes a feature extraction method that extracts signals from spatial and temporal patterns of components with high task covariance. For classification, the paper proposes a CNN classifier that classifies rest from other events, followed by a series of binary CNN classifiers, which classify each event against other events. The dataset used to test this system was developed by Ofner et al. (2017) where they measured the brain activity of all movements of the right arm (Elbow Flexion-Extension, Forearm Pronation-Supination, Hand Open-Close) of 15 participants in 10 runs.

In this paper, we will discuss the proposed model's setup, working and performance as follows – In the methodology section, The dataset, The feature extraction method and its theoretical basis are described along with the classification procedure. The result section will discuss the observed results and their significance. In the Discussion section, we will review our process, compare it with other papers and discuss limitations and potential research areas.

Methodology

1. Dataset Description

Ofner et al. (2017) developed the dataset used in this paper. To build this dataset, the authors built an experiment where brain activity was measured from the participants while they executed or imagined a right arm movement using EEG. Sensors were attached to the participant’s right hand, forearm and elbow to corroborate the brain activity with the executed movement. In this experiment, 15 participants participated, and ten such runs were taken for execution and imagination from each participant (Ofner et al., 2017).

This dataset was chosen to check the proposed model because it classified the data into six distinct movements occurring within the same limb. These characteristics help us to check whether the model can identify the different kinds of movement occurring within a small part of the motor cortex. Also, the dataset provides many repetitions for each event per subject, which allows repeated checking of the proposed method across the subjects. Moreover, this dataset has been utilised by numerous researchers, allowing for a comprehensive comparison of the model's efficiency against other existing models.

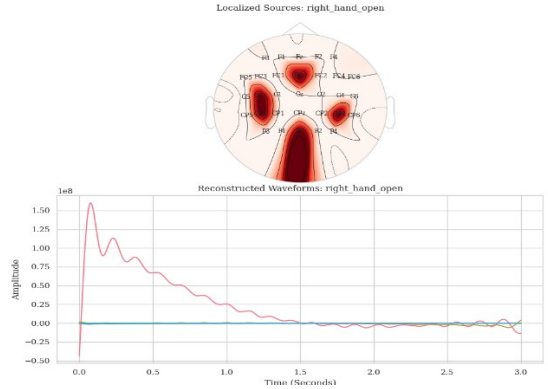
2. Proposed Method of Feature Extraction

The proposed feature extraction method is based on the task-related component analysis (TRCA) designed by Tanaka et al. (2013). This method uses temporal consistency across tasks to decompose the signal into a weighted sum of subcomponents. The output of TRCA is composed of components arranged in descending order of correlation and corresponding eigenvalues (Tanaka et al., 2013). This method accurately decomposes the signal based on the tasks provided. Due to this advantage, TRCA is useful for extracting features in signals generated from a smaller cortical area (In our case, the motor cortex).

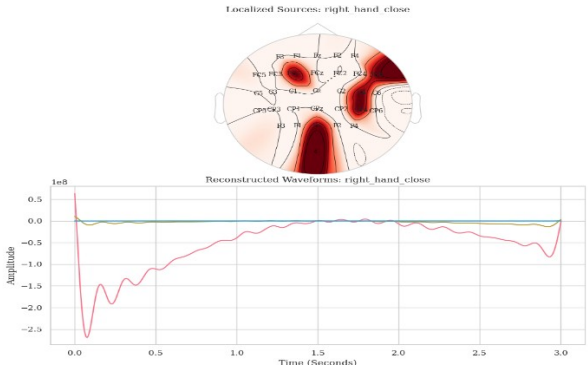
The proposed method extracts the signal's spatial properties and temporal patterns as features to classify 7 events using only TRCA. This method involves identifying the components with high task covariance (Represented in the form of a matrix) and finding the eigenvalues and eigenvectors for the component matrices. The eigenvector of the component matrix describes

the weights associated with the channels. In contrast, the eigenvalue represents the coefficient, when multiplied with the eigenvector, highlighting the temporal patterns distinct for each event.

Hypothetically, the spatial patterns for each event will be unique since actions related to each part of the body are represented by distinct populations of neurons in the motor cortex (Schott, 1993) and will improve the accuracy of the signal classification. The section below describes the derivation of the feature extraction module, which extracts the spatial and temporal patterns of the signal. The spatial and temporal patterns extracted from the signal are given below.



(A)



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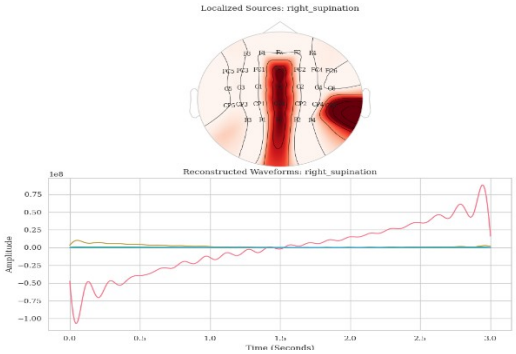

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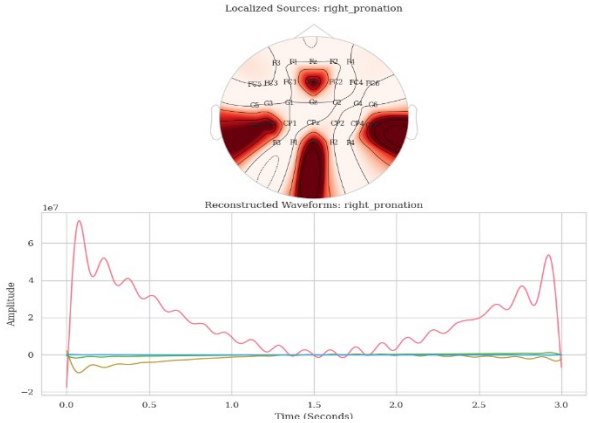

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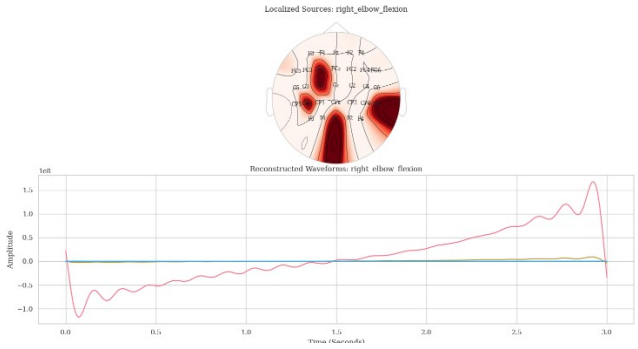

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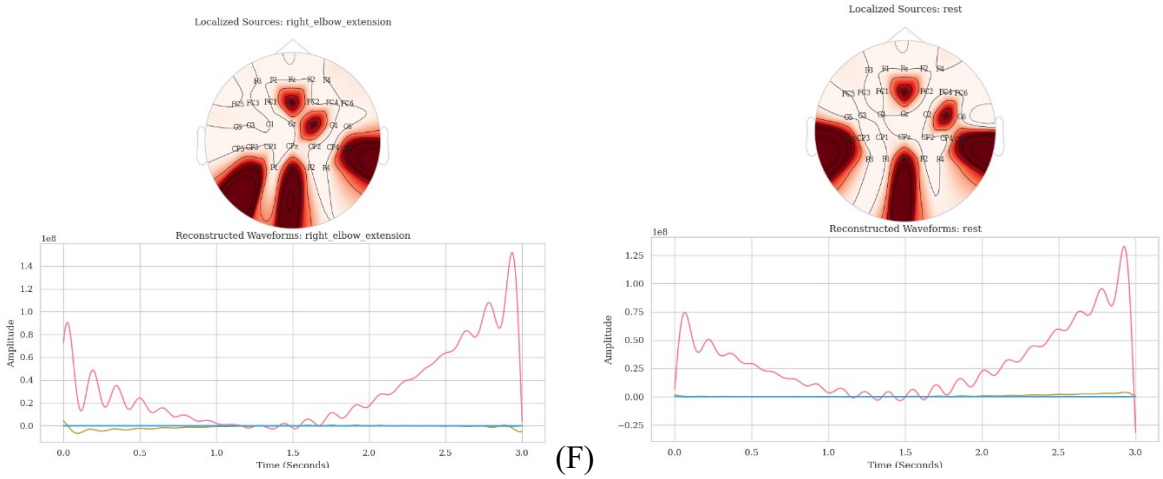


(F)

(G)

Figure 1 – Spatial and Temporal Patterns Detected using Proposed Feature Extraction Module, (A) Hand Open (B) Hand Close (C) Forearm Supination, (D) Forearm Pronation (E) Elbow Flexion, (F) Elbow Extension, (G) Rest

3. Mathematical derivation of Feature Extraction Module

The first four subjects from the dataset were loaded and filtered and were decomposed into C_i additive subcomponents. Later, the covariance matrix for each task (event) is calculated as

-

$$\boldsymbol{C_i = \mathrm{cov}(x_i)}$$

Where $'i'$ represents the number of trials and ' x' represents the data at i th trial.

Later, a weight matrix z is created to ensure the maximum correlation between trials.

$$\boldsymbol{z = \sum_{i=1}^{n} C_i C_{i+1}}$$

Later, the eigenvalues and eigenvectors of the matrix z are calculated and labelled as λ and V, Respectively.

Out of these eigenvectors, components with maximum task correlation were detected as

$$V = arg\ \max_{v} \sum_{i \neq j} T\, r\left(V^T c_i c_j V\right)$$

Later, the top 5 most associated components were selected. These components were placed in U a set.

$$U = [v_1, v_2, v_3, v_4, v_5]$$

Where v is a component with high task correlation.

From these components, weights were calculated for each event as

$$A_k = v_k \lambda_k$$

Where v_k represent the eigenvector from the set U; and λ_k Represent the corresponding eigenvalue.

The source of the signal for the specific event is identified by using the following function:

$$Localised\_Source(Event) = \arg\max(|A_k|)$$

Ultimately, we get two outcomes: the localised source for each event, which is an eigenvector, showing the channels from which the signal should be taken, and Adjusted A_k weights. Alternatively, each event describes the weight attached to each channel from which the signal is extracted. This results in waveforms unique to each event, which can be tested on a trained classifier.

4. Proposed Classifier Description –

The proposed classifier works in two steps. First, a binary CNN classifier separates rest from other events (movement vs rest). Later, a binary CNN classifier is used to classify data in all combinations of event pairs (movement vs movement). The CNN classifiers follow the same architecture, consisting of two convolution layers, each followed by a pooling layer. The first convolution layer is fitted with 64 convolutional filters, while the second convolution layer is fitted with 128 layers. A max pooling layer with a maximum pooling window of 2 follows both layers. The kernel size of each convolution layer is 3, and both are activated by the Rectified Linear Unit (ReLU) function. After that, the flattening layer is added, followed by the first fully connected layer with 128 neurons. Later, a dropout layer is added, which drops 50% of data out to prevent overfitting. Finally, an output layer of two neurons is added, and the output layer is finally given.

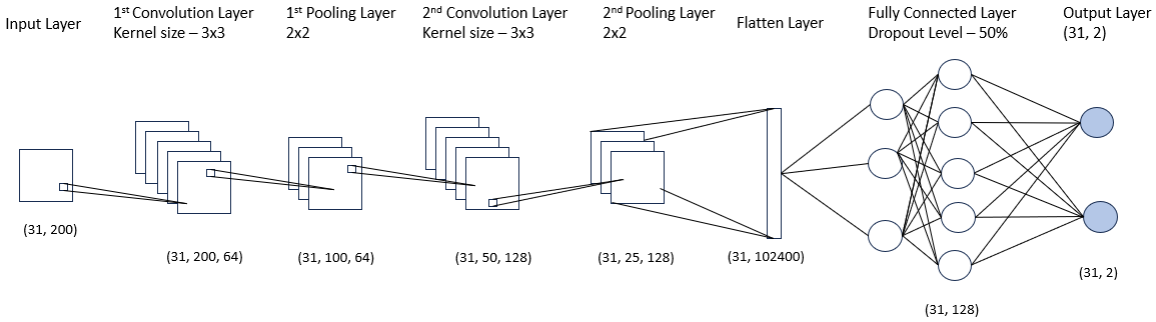


Figure 2 – CNN classifier Block Diagram Showing its layers and their properties. This CNN was used both for movement vs rest and movement vs movement classification

5. Procedure for testing –

At first, features were extracted from the data using the proposed feature extraction method in Offline condition (O). Then, the data was split into five datasets – 4 for training and 1 for testing, using the stratified K-fold method. This ensured that training and testing data would have the exact composition of events across sets. After the accuracies were recorded, the same procedure was followed for the Simulated Real-Time (SRT) condition. Training and testing data were fed to the proposed model in windows of 200 samples with a step of 100 samples each, i.e., at first, 200 samples were fed, and then 100 samples were fed with each increment. Accuracies from both conditions were recorded and compared, and the estimated accuracies were recorded by Jia et al. (2023). The accuracies were estimated with the help of the online app WebPlotDigitizer (https://automeris.io/).

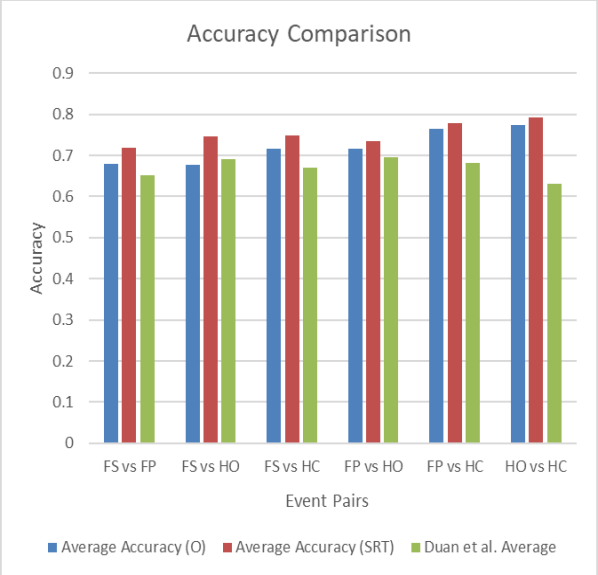
Results –

When the accuracies of the model were taken, it was found that the proposed model is more accurate in Simulated Real-Time (SRT) conditions than in Offline (O) conditions (p-value = 0.02247). The SRT condition gave up to 72.8% accuracy for six classes. The accuracy was up to 98% for the rest vs. other classifications. At the same time, comparing it with results from Jia et al. (2023). It was found that the accuracy of the proposed model was equivalent to that of Jia et al. (2023). However, the proposed model was more accurate in classifying events in event pairs where elbow movements (Flexion and Extension) were not involved (p-value = 0.005474). The results described above are shown in graph 1

Event Pair	**Average Accuracy (O)**	**Average Accuracy (SRT)**	**Jia et al. Average**
EF vs EE	0.696875	0.702777778	0.70105
EF vs FS	0.69375	0.690972222	0.72
EF vs FP	0.698958333	0.7375	0.76105
EF vs HO	0.695833333	0.730555556	0.71684
EF vs HC	0.723958333	0.729861111	0.74526
EE vs FS	0.70625	0.696527778	0.73236
EE vs FP	0.722916667	0.684722222	0.74211
EE vs HO	0.680208333	0.715972222	0.72316
EE vs HC	0.720833333	0.716666667	0.74236

FS vs FP	0.680208333	0.717361111	0.65053
FS vs HO	0.677083333	0.745833333	0.69158
FS vs HC	0.715625	0.748611111	0.66945
FP vs HO	0.715625	0.733333333	0.69474
FP vs HC	0.764583333	0.777777778	0.68211
HO vs HC	0.772916667	0.793055556	0.63158

Table 1. – Comparing Average Accuracies of the proposed model in offline (O) and Simulated Real-Time (SRT) conditions along with the accuracies given by Jia et al. (2023)



Graph 1. – Average Accuracies Comparison for event pairs without elbow movements of the proposed model in Offline and Simulated Real-Time conditions and accuracies given by Jia et al. (2023)

Discussion

As we see in Graph 1 above, the proposed model has shown more accuracy in event pairs without elbow movement; while keeping a significantly similar performance (p-value > 0.09) in event pairs with an elbow movement (Elbow Flexion – Extension). This observation suggests that the model shows more accuracy than the current state-of-the-art model proposed by Jia et al. (2023). The next step is to understand what factors and mechanisms of the proposed models contribute to the increased accuracy.

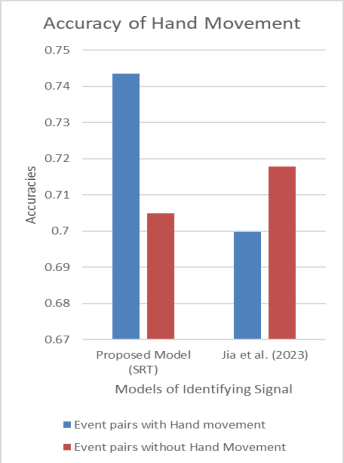
The primary observable difference between the proposed model and the Jia et al. (2023) model is the method of feature extraction used. Jia et al. (2023) also used TRCA to extract features, but they used TRCA to provide a spatial filter and later used Canonical Correlation Analysis (CCA) to extract features. The proposed model uses TRCA to provide spatial maps to localise the signal unique to the event and the eigenvalues derived from TRCA to maximise the differences between the present events. The spatial maps help us separate events, whereas the final reconstructed waveform is the time-domain feature, which enhances the differences between the events. Hence, the proposed model used spatial (spatial maps)

and time-domain features (Final Reconstructed Waveform) to classify upcoming signals, whereas, Jia et al. (2023) used only time-domain features to classify the events.

This difference might be correlated to the increase as follows – Spatial Maps based on TRCA extract the coordinates of areas involved in that specific task as a feature. Meanwhile, the time-domain features extracted are the changes in activation in these areas over time. Together, both of these features give more scope for discrimination.

An interesting observation related to using spatial maps as a feature extraction method in the proposed model is that the pairs where hand movement (Hand Open-Close) was present were significantly more accurate (74.8%) than those where hand movement was absent (70%). This observation was not seen in the accuracy recorded by Jia et al. (2023). This observation can be explained by the homuncular representation, which states that every sensory and motor mechanism for a particular body part is localised discretely on our brain's sensorimotor and motor cortices (Schott, 1993). This observation gives us a scope of opportunity and describes the limitations of this model.

One of the main observations in this study is the activation in the brain's parietal area, as seen in Figure 1. This observation was reported and investigated by Lorey et al. (2011). They found that parietal activation is associated with premotor activation (like the one seen here) and is strongly correlated with the 'vividness' of the movement, i.e., how the movement details are visualised.



Graph 2 – Comparison of event pairs with and without hand movement in the proposed model and Jia et al. (2023)

One of the first limitations is that this model might not be as accurate as other body parts with lesser representation in the motor and sensorimotor cortex, e.g., movement occurring within the leg, like knee flexion or ankle rotation. Also, changes in the homuncular representation may affect the performance of the proposed model.

However, this observation also brings in new opportunities to improve the accuracy of the proposed model. First, this model can be a solution to identify finger movement accurately by non-invasive means. Also, the proposed model can accurately identify complex motor tasks like grasping. Also, the findings related to the parietal activation in motor imagery (Lorey et al., 2011) can be used as an indicator to demonstrate the vividness and precision required for the movement.

Conclusion: -

This paper proposes a new model for extracting features to identify movements in motor imagery BCI. This proposed model is more accurate in identifying movements than the current state-of-the-art. This model has multiple applications, including stroke rehabilitation,

prosthetics, and VR. Further research can lead to an accurate and efficient Brain-Computer Interface, which offers a diverse set of possible commands.

Accessibility –

The code for building the feature extraction module for each event and the code applying it in Simulated Real-Time (SRT) conditions is accessible and is published on GitHub.

Brain gut coupling can predict the severity of levodopa induced dyskinesia in Parkinson's Disease

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IIT Kanpur

Introduction

Levodopa is commonly prescribed to patients afflicted with Parkinson's disease (PD). However prolonged use of it leads to dyskinesia (LID) (Cotzias GC et.al, 1967) which are involuntary and erratic movements of the limbs and neck which greatly reduces the quality of life of the patients. Recent literature also suggests even young patients can be at risk.

Although Parkinson's disease is widely recognized as a neurodegenerative disease, approximately 60–80% of patients with PD experience gastrointestinal (GI) symptoms as soon as just 4 years post - PD diagnosis (Pfeiffer et al., 2020). Gastric emptying through the intestines is considered as a critical modulator of levodopa absorption (Pfeiffer et al., 2020; Menozzi et. al., 2021) which in theory can be studied by a non-invasive measure like electrogastrogram (EGG), that senses gut motility signals sourced by Cajal cells lining the stomach and intestine.

Our current study assesses the feasibility of non-invasively collected gastric electrophysiological signals to characterize the risk of LID in PD patients, and even predict the same. Specifically, our study uses electroencephalogram (EEG) and electrogastrogram (EGG) simultaneously while performing cognitive tasks to estimate the phase amplitude coupling (PAC) (Özkurt T.E., Schnitzler A, 2011) between the brain and gut in age-matched healthy cohort and PD patients with LID.

Early characterization and prediction of the risk for LID will assist to strategize the treatment plan for any individual, suggest alternate treatments, and improve the treatment efficiency.

Methods

The cohorts consisted of Parkinson's patients with LID (n=36, Age = 58.9 ±10.5 years, 25 males & 11 females) and age matched healthy subjects (n=24, Age = 70 ±7.6 years, 12 males & 12 females). Participants walked into the study setup in a post-prandial state with meals consumed about 2 hours ago, and simultaneous EEG and EGG were recorded while the subjects performed cognitive tasks which were repeated before and after food/medicine consumption. Light snacks were provided to the healthy subjects while the LID patients received their prescribed l-dopa medication. MDS UPDRS (C.G Goetz et.al, 2008)

questionnaire was collected before the start of experiment for each subject. For further analysis, only parts 4.1 and 4.2 were considered which were related to dyskinesia.

The EEG data was preprocessed in EEGLAB (Delorme A & Makeig S, 2004) and bandpass filtered in the beta frequency range (13-30 Hz) while the EGG data was filtered in three frequency ranges : bradygastria (0.0083 - 0.03 Hz), normogastria (0.03 - 0.07 Hz) and tachygastria (0.07 - 0.15 Hz). The EEG electrodes were divided into 3 regions : frontal (mean of FP1, FP2, F3, F4, Fz), temporo-occipital (F7, T3, T5, O1, O2, T6, T4, F8) and centro-parietal (C3, Cz, C4, P3, Pz, P4). The phase amplitude coupling between EEG and EGG was calculated as described in Özkurt T.E., Schnitzler A, 2011. Heart related features were extracted from the EGG data itself by filtering in the range of cardiac rhythm (1.2-1.5 Hz).

Results

A repeated measures ANOVA model was constructed which showed that PAC could differentiate between the cohort status ($F=4.25$, $p=0.044$, $\eta^2=0.07$) and cognitive tasks ($F=73.23$, $p<0.0001$, $\eta^2=0.8$). Mediational analysis (Kenny et.al, 2003) was performed which showed that the relationship between pre-medication tachygastric EGG power and dyskinesia severity across cognitive tasks was mediated by both pre-medicaton EEG power in frontal and temporo-occipital regions. In our regression analysis, we found that PAC especially in the tachygastric EGG range with the temporo-occipital EEG beta band is sensitive to PD severity, and can further predict severity of dyskinesia during controlled cognitive states. We found that the above PAC had a significant interaction with pre-medication LF/HF ratio which is a measure of vagal tone.

Discussion

The project aimed to demonstrate the necessity of looking at brain gut coupling using non-invasive measures which could readily be deployed in clinics for addressing LID in PD patients. Also we found that PAC had a significant interaction with vagal tone which opens up the possibility of using vagal stimulation for improving the quality of life of patients with LID.

Resilience of temporal order judgment to early-onset, prolonged visual deprivation

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Project Prakash, MIT, IIT Delhi, Dr Shroff's Charity Eye Hospital

Introduction

How a newborn's initially unorganized visual experience of the external environment gets transformed into a sensorium of meaningful objects, as well as their inter-relationships, lies at the core of understanding early perceptual organization. A defining characteristic of the physical world, and an exploitable organizing feature is the 'temporal cohesiveness' of objects in the environment, with all constituents of individual objects occurring simultaneously or in close temporal proximity to each other (Cheries et al., 2008; Rosenberg & Carey, 2009). Hence, simultaneity of occurrence of two sensed features can serve as a strong indicator of their sharing a common source. Several studies have demonstrated that humans possess excellent facility at detecting simultaneity relationships between stimuli. However, the role of early experience in the acquisition and shaping of this proficiency remains unclear. Do we need to encounter instances of simultaneous and non-simultaneous events early in development to be able to detect such relationships later in life? Here we address this question by studying the status of this skill in children treated for congenital cataracts. Past work with this population has demonstrated the detrimental consequences of early-onset and prolonged visual deprivation can have on several spatial visual functions (Ganesh et al., 2014; Gupta et al., 2022). This study extends investigations into the temporal domain, specifically focusing on the detection of co-occurrence.

Methods

Participants were 14 individuals (7 females, mean age: 15.8 years) who had dense bilateral cataracts detected before one year of age. All had profound visual impairment, with preoperative acuities ranging from 20/500 to <20/1000. As part of a humanitarian effort, they were provided cataract surgeries. All children had had at least one year of post-operative vision before enrolling in this study. Their performance was compared with that of 22 controls (21 females, mean age: 19.0 years) with normal or corrected-to-normal vision. Control experiments were performed with on-screen blurring to roughly match the post-operative visual acuity of patients.

The experimental paradigm was adapted from Elliot et al. (2007), wherein two vertical bars, horizontally displaced relative to each other, were presented with varied temporal delays, and participants judged if their presentation was simultaneous or not. In our study, we enlarged the visual display to accommodate the sub-par acuity of our participants and to ensure task awareness and reduce bias, we asked participants to judge which bar appeared earlier (i.e. a

temporal order judgment task). The temporal delays included 10 different values sampled non-uniformly within a wide range from 17ms to 500ms (17, 33, 50, 67, 83, 100, 150, 200, 300, 500ms).

Following 10 test trials, the main experiment comprised 100 trials (10 trials per temporal delay value) with the presentation order randomly shuffled for each participant. Each trial began with a central fixation point (500ms), followed by a blank screen (50-100ms), and then transient presentation of one of the bars (either left or right). Between 17 and 500 ms after the first bar's appearance, the second bar appeared as well. After both bars disappeared, participants were asked to report which bar had appeared first. We fitted psychometric functions to individuals' performance data and extracted the threshold (in ms) required for achieving 75% performance.

Results

The patient group performed remarkably well and was at least on par with controls, with mean thresholds of 134 ms for the late-sighted group and 185 ms for the controls (Bayes Factor BF_{10} = 0.15 in one-tailed two-sample t-test of individuals' thresholds, revealing moderate evidence in favor of the null hypothesis that late-sighted individuals are not inferior to controls). Thus, one or more years post-surgery, patients treated for congenital cataracts were able to judge the order of two temporal events at least as well as normally-sighted blur-matched controls.

Discussion

Our results reveal that temporal order judgment is resilient to early-onset, prolonged visual impairment. This study adds to past work showing that late-sighted individuals possess the ability to acquire many visual proficiencies late in life, such as categorical face perception, visual memory capacity, and cross-modal mappings (Gandhi et al., 2017; Gupta et al., 2022; Held et al., 2011; Senna et al., 2021). This work also extends previous findings in the domain of temporal perception, which had demonstrated that basic temporal contrast sensitivity is notably resilient to visual deprivation, much more so than its spatial equivalent (Ye et al., 2021).

In the future, it would be interesting to examine cross-modal temporal judgements of simultaneity. Also, longitudinally studying the development of this perceptual capability at different timepoints after surgery could help establish the time course of acquiring this fundamental skill. This could help understand whether simultaneity detection as a mechanism for perceptual organization and binding is available immediately at sight onset or, instead, requires a protracted period to become manifest.

Prosocial skill development in adolescents through video game interleaved with an online course: An intervention study

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CBCS, University of Allahabad

Introduction

Prosocial behavior, defined as voluntary actions intended to benefit others, plays a critical role in adolescent development, fostering social and emotional competencies. Social and Emotional Learning (SEL) frameworks, as conceptualized by the Collaborative for Academic, Social, and Emotional Learning (CASEL), emphasize five core competencies—self-awareness, self-management, social awareness, relationship skills, and responsible decision-making—that are essential for holistic development (CASEL, 2020). Digital interventions have emerged as effective tools for promoting these competencies, particularly in adolescents who are at a pivotal stage of social and emotional growth. This ongoing study investigates the effects of a novel intervention combining the prosocial video game "SKY: Children of Light" with the "Becoming Us" online course developed by MGIEP UNESCO. The intervention aims to enhance prosocial behaviors by leveraging both implicit learning through gameplay and explicit instruction through structured online modules.

Methods

This ongoing study employs a within-subjects design with 9 adolescents aged 12-15 years from an English medium school in Allahabad. Participants were selected based on their scores on the Prosociality Scale (Caprara et al., 2005), with only those scoring within ±1 standard deviation of the mean recruited to ensure a representative sample. The Wechsler Abbreviated Scale of Intelligence (WASI-II) was also administered to confirm that all participants had average or above-average intelligence. The intervention spans three weeks, during which participants alternate between playing "SKY: Children of Light" and completing the "Becoming Us" online course, which covers topics such as trust, cooperation, and emotional regulation.

Assessments are conducted at three time points—pre-intervention, post-intervention, and one-month follow-up—using three experimental tasks:

Resource Allocation Task: Adapted from Güroğlu et al (2014), this computer-based task measures participants' fairness in resource distribution. Participants are required to allocate coins between themselves and four types of interaction partners: friends, neutral peers, antagonists, and anonymous individuals. The task includes three conditions—costly, non-costly, and disadvantageous—designed to assess the extent to which participants are willing

to make sacrifices for the benefit of others. Fairness is operationalized as the preference for equal distribution of resources across these varying conditions.

Trust and Reciprocity Tasks: Derived from Berg et al (1995), these pen-and-paper tasks are designed to assess the levels of trust and reciprocity in social exchanges. In the trust task, participants decide whether to share their resources with a partner, with the understanding that the partner may or may not reciprocate. The reciprocity task reverses these roles, with participants deciding whether to reciprocate after receiving resources from a partner.

Affective Perspective-Taking Task: This task, adapted from Marie et al. (2019), evaluates participants' cognitive empathy by measuring their ability to understand and predict others' emotional states. Participants view brief video clips depicting emotional scenarios, followed by images showing emotional expressions, and are asked to judge whether the expression matches the preceding scenario. This task assesses the participants' sensitivity to others' emotions, an important aspect of prosocial behavior.

Results

Results from this ongoing study indicate a significant increase in prosocial behavior, particularly in fairness-related decisions and trust-based interactions. The Resource Allocation Task revealed that participants made more prosocial choices post-intervention, with a significant increase in fairness towards friends and neutral peers, and a modest but notable increase towards antagonists. Repeated-measures ANOVA showed that choices become increasingly prosocial from pre- to post-intervention and at follow-up after one month. The Trust and Reciprocity Tasks revealed that participants were more likely to trust and reciprocate with friends than with neutral or anonymous partners, aligning with previous findings on adolescent social development (Güroğlu et al., 2014). The Affective Perspective-Taking Task did not show immediate significant improvements, although there was a positive trend at follow-up, suggesting that extended exposure to the intervention might be necessary for significant changes in cognitive empathy.

Discussion

The current study contributes to the growing evidence supporting the use of digital games combined with structured educational modules to enhance prosocial behavior in adolescents. The "SKY: Children of Light" game provides an engaging platform for implicit learning, allowing participants to practice prosocial behaviors in a virtual environment. Concurrently, the "Becoming Us" course developed by MGIEP UNESCO reinforces these behaviors through explicit instruction and reflection, offering a comprehensive approach to Social and Emotional Learning. The preliminary findings underscore the effectiveness of a spaced intervention strategy, as the combination of immediate and follow-up assessments indicates that the effects of the intervention may be more pronounced over time. The study highlights prioritization of fairness in resource allocation in adolescents compared to the moral goal of welfare (McGuire et al., 2018). The fairness norm emerged as a proxy for prosocial behavior. As this study progresses, further data is being collected to validate the findings and explore the scalability of such interventions for broader application in educational settings.

Spectral Analysis of Novice Reflective States: The Role of Gamma and Delta Power on Performance During Breath-Focused Meditation

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Introduction

Meditation has garnered considerable attention for its positive effects on cognitive and emotional regulation, with increasing empirical research elucidating the underlying neural mechanisms (Lomas et al., 2015; Tang et al., 2015). Meditation involves various techniques that elicit different brain activity patterns, indicating a complex relationship between meditative states and neural oscillations (Lutz et al., 2008; Travis & Shear, 2010). Different spectral powers correlate with specific meditative states and behaviors (Aftanas & Golocheikine, 2001). This study investigates the impact of spectral powers on breath count characteristics during the Breath Counting (BC) stage in novice meditators in a breath-focus-based meditation intervention, focusing on the midline Default Mode Network (DMN), Prefrontal Cortex (PFC), and Occipital Cortex (OCC). The DMN, known for its role in self-referential thoughts and mind-wandering, can be modulated through meditative practices (Brewer et al., 2011). The PFC is critical for executive functions, including cognitive control and emotional regulation, often enhanced through meditation (Hölzel et al., 2011; Tang et al., 2009). The OCC, involved in visual processing, also plays a role in attentional processing during meditation (Kozhevnikov et al., 2009).

Methods

A sample of university students (N=89, Mean Age = 24.6 years) with no prior meditation experience participated following a breath-based meditation intervention to assess neural and subjective responses during different stages of meditation: Resting State (RS), Breath Counting (BC), and Breath Focus (BF). Participants performed a breath-counting task during the BC stage while EEG data were collected, requiring them to count their breaths and report confidence, distraction levels, and blissful sensations. EEG data from the DMN, PFC, and OCC regions measured oscillations across five spectral bands: delta, theta, alpha, beta, and gamma. Data were recorded using 64 electrodes in an extended International 10-20 system. Preprocessing involved artifact rejection/correction using ASR-ICA (Artefact Subspace Reconstruction-Independent Component Analysis) methods and Fourier spectral analysis using MATLAB vR2021a and EEGLAB v2023.1. The study followed strict privacy and confidentiality protocols, adhering to ethical principles set by the Indian Council of Medical

Research, and received approval from the Institute Ethics Committee of the Indian Institute of Technology, Delhi (IEC-IITD; Proposal No. P021/P0101).

Results

Correlation analysis for the BC stage between oscillation amplitudes in the three brain regions and breath-counting dimensions was conducted. Bonferroni correction for multiple comparisons established the significance level at $\alpha = 0.003$. Breath confidence was negatively correlated with PFC-delta oscillations ($r = -0.335$, $p_{adj} < 0.003$), indicating higher confidence in breath counting associated with lower delta activity in the PFC. PFC-delta oscillations showed marginally significant impacts on Breath-Distract ($r = 0.292$, $p = 0.005$) and Breath-Blissfulness ($r = -0.279$, $p = 0.008$), though these did not survive Bonferroni correction. Breath count exhibited substantial positive correlations with gamma power across the three regions: DMN ($r = 0.40$, $p_{adj} < 0.003$), OCC ($r = 0.41$, $p_{adj} < 0.003$), and PFC ($r = 0.34$, $p_{adj} < 0.003$). Post-hoc analyses revealed increased gamma power relative to the resting state in the OCC ($r = 0.43$, $p < 0.0001$) and DMN ($r = 0.29$, $p = 0.0052$). Lastly, Breath count correlated positively with occipital beta power ($r = 0.31$, $p_{adj} < 0.003$).

Discussion

The findings indicate heightened gamma oscillatory activity in the DMN, OCC, and PFC associated with increased breath counts, suggesting improved cognitive processing and attentional engagement during meditation, further supporting the apriori gamma oscillations' meditation-based results (Braboszcz et al., 2017; Cahn et al., 2010). The beta-band results highlight the occipital cortex's significance in novice's breath counts, given a positive correlation, suggesting enhanced visual and attentional processing during the BC stage (Huang & Lo, 2009). The negative correlation between PFC-delta oscillations and

Breath-Confidence, alongside marginally significant findings related to Breath-Distract and Breath-Blissfulness, aligns with prior research indicating decreased frontal delta activity during meditative states (Cahn et al., 2010; Fell et al., 2010). Reduced delta activity in the PFC may enhance cognitive control and emotional regulation during the BC stage rookie mediators' performance. These results contribute to understanding the neural mechanisms underlying meditation, providing empirical evidence for the role of specific spectral powers in modulating meditative states and behaviours.

The Costs of Action Effect Monitoring

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Actions are performed to produce sensory effects in the environment. Ideomotor theory provides a framework to explain the relationship between action and its sensory consequences: actions are represented by the sensory outcomes they produce and hence, selecting an action involves anticipating its sensory effects (Hommel et al., 2001). Under this framework, action-effect monitoring refers to a mechanism that compares the predicted sensory effects of an action with those that are perceived. Recent studies employing dual-tasking paradigms have shown that action-effect monitoring postpones the perception of stimuli presented after the appearance of an action-effect (Wirth et al. 2018). Furthermore, action-effect monitoring has been shown to guide visual attention and enhance attention capture (Kumar et al. 2015; Gozli et al., 2016).

In the present study, we aimed to further investigate the properties of action-effect monitoring by examining if and how action-effect monitoring produces performance costs in a subsequent but related task. Specifically, we asked the following questions: (1) Does the predictability of action-effects influence performance on subsequent tasks? and (2) If costs are produced, do they persist in passive viewing or no-action conditions? We conducted three experiments with a modified irrelevant-singleton visual search task to answer these questions.

Experiment 1

The first experiment was performed to identify how predicted and unpredicted action-effects influence performance in a visual search task.

The experiment began with a white fixation cross. 300 ms later, a 1000 Hz tone was played, signaling the participants to make an action by pressing the spacebar. Pressing the spacebar led to the fixation cross changing from white to red in 70% of trials (predicted action-effect) and green in 30% (unpredicted action-effect; colors counterbalanced). The action-effect remained on the screen for 150 ms and was followed by the onset of the visual search display, consisting of 4 or 8 items. One of these items was the irrelevant singleton. In this experiment, the colour of the irrelevant singleton was always congruent with the predicted action-effect. Participants were asked to search for targets 2 or 5, one of which was always present in the search display. They were instructed to press the right-arrow key for 2, and the left-arrow key for 5 (counterbalanced).

Across 576 trials in 27 participants, three factors were systematically manipulated and submitted to a repeated-measures ANOVA: (1) prediction condition (predicted action-effect or unpredicted action-effect); (2) target condition (whether the target was a singleton or a non-singleton); and

(3) set size (4 or 8 items).

The data from the first experiment showed that responses to targets after unpredicted action-effects were slower than after predicted action-effects ($F (1, 26) = 12.93$, $p = 0.009$, $\eta_p^2 = 0.332$) in both set-sizes regardless of whether the target was a singleton. Therefore, experiment 1 demonstrated that monitoring unexpected action-effects slows down visual search performance and produces a cost in response time.

Experiment 2

An alternate explanation for the results of the first experiment was that the pre-activation of the expected action-effect led to the faster selection of feature-congruent visual search targets instead of unexpected action-effects being monitored for longer. Experiment 2 was performed to account for this possibility. The experimental paradigm remained the same as experiment 1, however, the action-effect predictability was set to 100% and the colour of the irrelevant singleton was congruent with the predicted action-effect in only 70% of trials.

Reaction time data from 27 participants indicated that there was no significant difference in visual search performance regardless of whether the feature-singleton was congruent with the action effect or not ($F (1, 26) = 1.04$, $p > 0.999$, $\eta_p^2 = 0.038$).

The insignificant main effect of the singleton-feature congruence in experiment 2 indicates that preactivated action effects do not lead to a faster selection of feature-congruent stimuli, thus making it unlikely that preactivated action-effects lent a benefit to visual search performance in experiment 1.

Experiment 3

The third experiment served as a control condition to the first and aimed to discern the role of actions in producing costs in visual search performance. The experimental parameters remained identical to the first experiment with the following exception: the participants did not perform any action to produce the action-effect. Instead, they passively viewed the fixation cross as it changed colors.

Data from 14 participants indicated no difference in visual search performance regardless of whether the action-effect was predicted or not. ($F (1, 13) = 0.028$, $p > 0.999$, $\eta_p^2 = 0.021$). In stark contrast to the first experiment, there was no difference in the response time to predicted/unpredicted visual search targets when the participants performed no action.

Conclusion

Ultimately, the three experiments conducted here reveal that unpredicted or unexpected action-effects increase response time to subsequently presented stimuli. But, predicted action-effects do not lead to a faster selection of feature-congruent targets. And finally, no performance costs are observed if visual effects are passively perceived. Consequently, slower responses to targets preceded by unpredicted action-effects are likely to arise from longer action-effect monitoring. Therefore, action-effect monitoring produces costs in processing visual stimuli.

Exploring the Impact of Monetary Value on Retrieval-Induced Forgetting

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Introduction

Selectively retrieving details from memory results in forgetting related information. This phenomenon is known as retrieval-induced forgetting. It was first introduced in the paper "Remembering Can Cause Forgetting: Retrieval Dynamics in Long-Term Memory" by Michael Anderson, Robert Bjork, and Elizabeth Bjork in (1994). Retrieval-induced forgetting is a well-established phenomenon in young adults, children, and older adults (Zellner & Ba¨uml, 2005; Moulin et al., 2002). Research has found that retrieval-induced forgetting can occur with verbal and visual material.

This phenomenon has proven to be relevant in many different contexts, such as autobiographical memories, event narratives, episodic and semantic memory, fact learning, false memories, goals, languages, mathematic operations, memory for perceptual experiences, motor actions, phonological categories, propositions, recall and recognition, scripts, self-performed actions, social cognition, spatial locations, visuospatial materials, visual scenes, and word-fragment completion tasks (Bäuml et al., 2005; Storm et al., 2015).

Retrieval-induced forgetting has been extensively observed in various contexts and measured using different methods. However, the role of monetary value and its impact on forgetting and retrieval has yet to be explored. This research examines the link between retrieval-induced forgetting (RIF) and monetary values, shedding light on how RIF influences economic memory and decision-making processes, particularly regarding monetary value.

Methods

The study has adopted a between-group design with two conditions. The sample comprised of 84 young adult college going students with male and female representation. The study used a convenient sampling method with random assignment.

There are two groups, resulting in a total sample size of 63. Participants were randomly assigned to each group, ensuring that two groups are comparable at the start of the study. In the first condition, participants were retrieved high-value items during the practice retrieval phase. In the second condition, participants were retrieved low-value items during the practice retrieval phase. Participants in the study were shown a visual stimulus using PsychoPy. Both experimental groups underwent the test, and their scores were assessed and compared using "Jamovi 2.4.8".

We have selected 40 visual stimuli for the study which is divided into four categories:

bags, shoes, electronics, and watches. Each category contains ten stimuli, half with high value and half with low value. The stimuli will be displayed for 5 seconds each, totalling 200 seconds. The inclusion criteria for the study require participants were to be fluent in English and over 18 years old. The study excluded participants taking medication that could affect

their memory and cognition and those experiencing auditory or visual impairments that could interfere with completing study tasks. Additionally, participants with substance abuse were not included.

Procedure

Participants were fully informed about the experiment, and their consent was obtained before being assigned to either the high-value or low-value group, ensuring fairness. The experiment consisted of four phases: a learning/study phase, a retrieval practice phase, a distractor task phase, and a final recall phase. Participants were shown visual stimuli using PsychoPy in the study phase, including high or low-monetary-value objects. There were 40 stimuli in the study phase, each presented for five seconds. During the retrieval practice phase, each group were practicing recalling objects of their assigned value. Following this, both groups engaged in a distractor task involving listing ten distinct animals corresponding to each alphabet letter within a 5-minute time limit. In the recall phase, participants were asked to recall all the objects presented in the study phase and type their responses into the PsychoPy software, regardless of completion of the distractor task.

Results

The study was conducted on individuals aged 18-30 years. About 60% of the sample was Male participants, and about 40% were female participants. A Shapiro-Wilk Test was conducted to verify the assumptions of normality for the variable retrieval-induced forgetting among High and Low monetary value conditions. The test indicates no univariate normality violations in High (W=0.972, p= 0.523) and Low (W=0.953, p=0.176) monetary value conditions. The independent sample t-test analysed the differential effects of retrievalinduced forgetting on monetary value conditions (High, Low). The test showed that individuals who belonged to the High monetary condition (M=5.94, SD=2.75) showed higher level retrieval-induced forgetting (t=7.62, p=<0.01, d=1.89) than individuals who belonged to low monetary value conditions (M=0.25, SD=3.25).

Discussion

The study provided evidence supporting the hypothesis that retrieval-induced forgetting is significantly higher for items with high monetary value compared to those with low monetary value. Retrieving low monetary-value items did not cause the forgetting of high-value items, while retrieving high monetary-value items led to the forgetting of low-monetary-value items.

This suggests that the perceived value of information can significantly influence its susceptibility to forgetting. It is important to acknowledge the limitation of the study, as the visual stimuli chosen may be familiar to some participants. Additionally, the concept of monetary value can vary among participants. Despite these limitations, the current findings provide valuable insights into the relationship between monetary value and memory. Further research should address these limitations.

Exploring the role of conceptual mappings in attentional engagement during metaphor processing

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Introduction

Metaphors have long been of interest to both psycholinguists and cognitive scientists more generally, especially due to the influential Conceptual Metaphor Theory of Lakoff and Johnson [2008]. While it is generally held that metaphors help us make sense of more abstract ideas or concepts in terms of more concrete, embodied ones, the way this is realised at the level of sentence processing is not fully understood. Correspondingly, though conventional metaphors are very commonly used, it is not entirely clear as to why they are so prevalent in everyday language. There is evidence to suggest that metaphorical expressions are more engaging than their literal counterparts [Mon et al., 2021]. However, the reasons for this remain unclear, and the fact that metaphors lead to greater allocation of attentional resources than their literal paraphrases seems, *prima facie*, to conflict with the idea of them serving to facilitate the cognition of abstract or complex ideas.

Mon et al. [2021] examined the hypothesis that the greater engagement may reflect additional semantic content carried by metaphors, leading to more downstream inferences. However, their pupillometric study does not support this conclusion. They nevertheless suggest that metaphors carry 'richer meaning' than literal paraphrases, without giving a precise characterisation of what such 'richness' means. Building on such previous findings, this study seeks to better understand why and under what conditions metaphors elicit greater engagement. In particular, we seek to ask if attentional allocation of resources to metaphor processing might relate to implicit semantic mapping involved in understanding a metaphor, *i.e.*, the mapping from a more concrete *source* idea or concept to a more abstract *target* idea/concept. This draws on the Lakoff and Johnson [2008] notion of metaphors as a broader conceptual mapping between source and target domains. Our specific question is whether the semantic *distance* between source and target concepts plays a role in engagement during metaphor processing.

Methods

We use a data set of metaphors from Mon et al. [2021]. Their study employs a pupillometric design, usingpupil dilation asan index of engagement, while participants passivelylistento metaphoric and literal sentences which were matched on a range of other possible measures of processing difficulty. They also collect human ratings of metaphoricity for each sentence in their data. Here, for each metaphor considered, we manually annotate it with the our judgement of the implicit source and target concepts (see Table 1 for examples). To concretely represent the semantics of these concepts, we pick one specific noun corresponding to each concept, based on the highest observed frequency in the training set of

the Gigaword headline generation corpus [Graff et al., 2003, Rush et al., 2015], consisting of 3.8 million sentences with 127 million tokens.

To assess the role of conceptual source-target mappings in metaphor processing, we sought to quantify the semantic distance between the chosen nouns corresponding to the source and target concepts for a given metaphor. For this, we adopt a distributional semantics approach drawing on the previous work of Shutova and Sun [2013]. First, the Gigaword corpus was parsed using the Stanford dependency parser [Qi et al., 2020], to extract labeled dependencies for grammatical relations between words. Subsequently, for all nouns of interest (those corresponding to source and target concepts), we counted the number of times they occur in a subject, direct object, or indirect object dependence relation with each verb in the corpus. Hence, we obtain a distribution of verb dependence for each noun, which is normalised to give a probability vector. The semantic distance between any two nouns is then computed using Jensen-Shannon divergence between their respective probability vectors. This gives us a data-driven estimate of the semantic distance between the source and target concepts involved in a particular metaphor, and we then look at how this might relate to the human-judged metaphoricity of that expression, and in turn to the degree of engagement it elicits during processing.

Results

Table 1 shows our initial results on a small set of examples. For each metaphor, we indicate the inferred source-target mapping, the specific choice of nouns to represent these concepts, the semantic distance computed between those nouns, and the human metaphoricity rating of the example from the norming study of Mon et al. [2021].

As a reference point for assessing the semantic distance values, note that the distance between *rise* and *fall* (antonyms, and hence with closely related typical contexts) is **0.411**; and that between *remark* and *comment* (synonyms) is **0.433**. Hence, the range of variation in source-target semantic distance across our metaphor examples seems fairly meaningful. The most striking observation is that the instances with lower metaphoricity tend to have *higher* source-target distance than the instances with higher metaphoricity. This points to an inverse correlation between the two quantities, also observed in their correlation coefficient of **-0.60**. In turn, this suggests an inverse relation between source-target distance and attentional engagement, since Mon et al. [2021] found a significant positive relation between metaphoricity and engagement. Of course, these associations are speculative and based on only a small number of data points for now; we are investigating them more extensively.

Discussion

While this is an ongoing study, our preliminary results suggest two notable things. First, that there is considerable variation in the semantic distance between the source and target concepts involved in conventional metaphor, and hence that this could be a relevant factor in understanding metaphor.

Metaphorical sentence	**Conceptual mapping**	**Source noun**	**Target noun**	**Metaphoricity (0–100)**	**Semantic dist. (0–1)**
[Lower Metaphoricity]					
The chef acquired more confidence after the positive reviews.	ATTITUDE is RESOURCE	property	confidence	45.18	0.748

The firefighters couldn't contain their rage.	EMOTION is SUBSTANCE	fire	feeling	60.12	0.765
The actor gave his co-star a sweet compliment.	THOUGHT is FOOD	food	comment	64.47	0.701
[Higher Metaphoricity]					
The soccer player fell short of scoring enough goals.	ACCOMPLISHMENT is DISTANCE	rise	performance	72.95	0.602
The determined workers were quickly climbing the ladder of success.	SUCCESS is HEIGHT	rise	success	78.82	0.647
The renters soaked up the view from their new cabin.	SENSATION is LIQUID	water	view	84.24	0.706

Table 1: Some example metaphors, with our suggested underlying conceptual mapping and chosen representative nouns for the source and target concepts.

The human-rated metaphoricity [Monetal., 2021] and computed semantic distance between source and target are reported for each instance. processing. Second, that there may be a negative relationship between source-target semantic distance and the engagement a metaphor elicits. What might this tell us about the role of greater attention in metaphor processing? One hypothesis is that the need for greater cognitive resources may especially arise in cases where the metaphorical word/phrase maps between concepts that are relatively close in meaning. This may point to some kind of underlying interference effect, where the activation of the source meaning of a metaphorical term may interfere with its intended interpretation in the target domain. We hope to investigate this more closely by creating larger data sets of metaphors grouped by source-target distance, and collecting additional pupillometric data to better understand how variation in the nature of the semantic mapping involved may affect metaphor processing and engagement. Such studies may provide one direction towards resolving the apparent paradox of metaphors seeming to require greater cognitive resources to process than literal paraphrases, despite their use being so pervasive in natural language.

Understanding the Navigation Network System- An fMRI investigation

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Introduction

Spatial navigation is a complex cognitive process that requires more than just the comprehension of the affordances in the scene. It requires integrating and processing information from multiple senses arranged by a vast network of interconnected brain areas. This study is focused on understanding the navigational network system and scene perception network using functional magnetic resonance imaging (fMRI) data. Our interdisciplinary approach, drawing from neuroscience, cognitive psychology, and brain imaging, allows us to delve into the complexities of spatial navigation. The study brings together past literature to hypothesize a fundamental navigational network system that includes scene processing and other cognitive system interactions like object perception, memory, orientation, and executive function to conduct effective navigation. This network was then partially validated with preexisting data. We utilized the raw dataset from Boccia et al. (2022) to generate activation maps for scene perception and imagery. These maps were then compared with the metaanalysis navigation association test map. The findings revealed a strong regional similarity between the activated voxels associated with scene perception and navigation, spanning from occipital to posterior parietal regions to medial temporal regions. This research contributes to the understanding of the shared neural mechanisms underlying both passive viewing or imagining of scenes and active engagement in navigational tasks. It suggests that mental path tracing, traditionally thought to depend on the overt, conscious goal of navigating through a scene, might also occur spontaneously as a result of simply viewing the scene, driven by a dynamic visual routine.

Objective

The project aims to investigate the regional similarities between the brain networks involved in mental navigation and the passive perception and imagery of scenes. Spatial navigation encompasses an all-round process integrating perception, memory, decision-making, attention to landmarks, and short-term memory for goals (Fig.1). Even when not explicitly prompted, the brain inherently processes these navigational cues. As Bonner et al. (2017) demonstrated, the brain encodes affordances simply through viewing scenes. Therefore, the present study hypothesizes that through the mere passive viewing of scenes, the brain constructs various navigational pathways based on the infusion of these affordances and selects the most effective one for navigation.

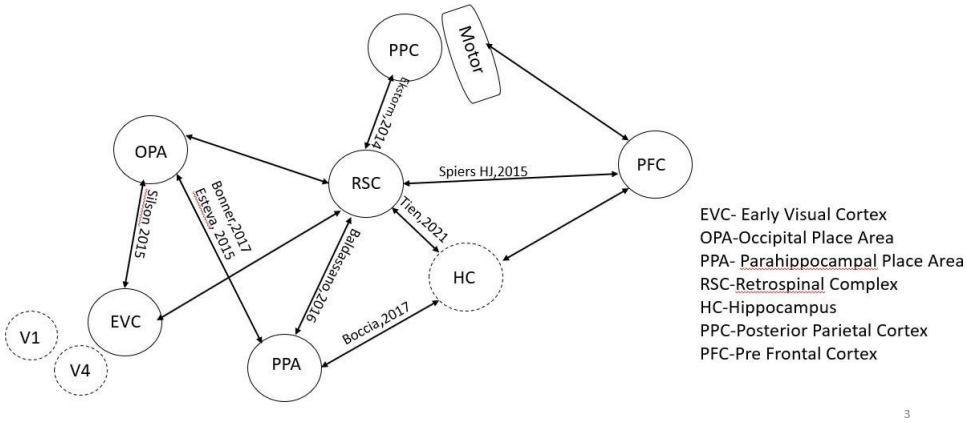

Fig. 1 Hypothesized spatial navigation network based on past literature.

Methods

The initial step in the analysis involved conducting a neuroimaging meta-analysis using Neurosynth (neurosynth.org) to identify brain regions activated during navigation tasks based on previous literature. In January 2024, the Neurosynth database was queried with the search term "navigation," yielding 77 studies with 3908 activations. The resulting association map for "navigation" was extracted, indicating whether activation in a region is more consistent for studies mentioning navigation than those that do not, controlling for base rate differences between regions. Clusters larger than 100 voxels and $z>3.1$ were included as nodes for the Regions of Interest (ROIs) to construct the navigational network, described by their corresponding anatomical labels in the Brodmann area atlas.

Secondly, raw data from Boccia et al. (2023), were obtained and pre-processed using a standardized pipeline in the FMRIB Software Library (FSL). The scene perception maps were then compared to the navigation network map constructed from the meta-analysis. The number of activated voxels and average BOLD activity in the overlapping regions of navigation and scene perception were reported. The scene imagination map was used as a baseline to eliminate activated voxels in regions typically active during any visual cognitive task.

Results

The meta-analysis for the navigation map identified 20 ROIs across the temporal, occipital, parietal, and prefrontal lobes. The rough abstract network for visualisation of this map is shown in Fig.2 Peak activity was observed in the hippocampus, para-hippocampal gyrus, fusiform gyrus, lingual gyrus, retrosplenial cortex, and insula (temporal lobe); precentral gyrus, premotor-supplementary motor cortex, and right angular gyrus (parietal lobe); and the visual association area bilaterally and left primary visual area (occipital lobe).

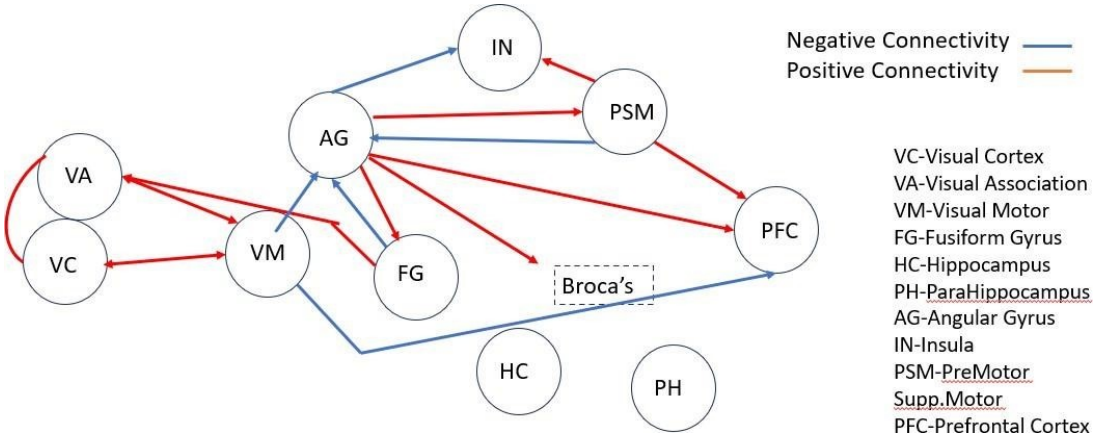

Fig.2 Navigational Network System (meta-analysis)

The analysis compared navigation maps to scene perception and imagination maps, identifying ROIs using the Structural Atlas. Z scores for scene perception ranged from 4.6 to 5.1 and for imagination from 3.5 to 4.2. Overlap between navigation and scene perception maps was in subcortical structures like the hippocampus and cingulate gyrus, with some activity in the lateral occipital cortex (Fig.3). Overlapping regions between navigation and scene imagination maps were primarily in the occipitoparietal and medial temporal regions. Fig.4 depicts the proportion of activated voxels in different ROIs in navigation, scene perception and scene imagination.

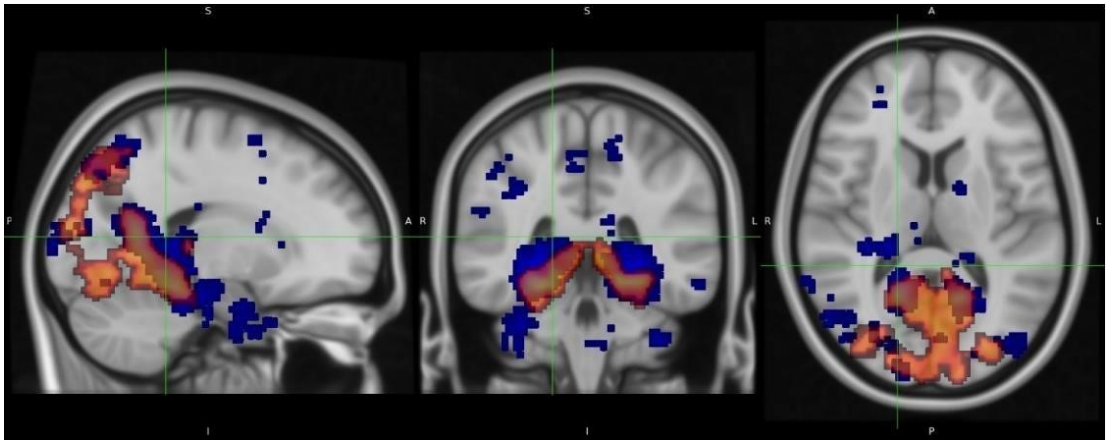

Fig.3 overlapping ROIs between navigation (blue) and scene perception (orange)

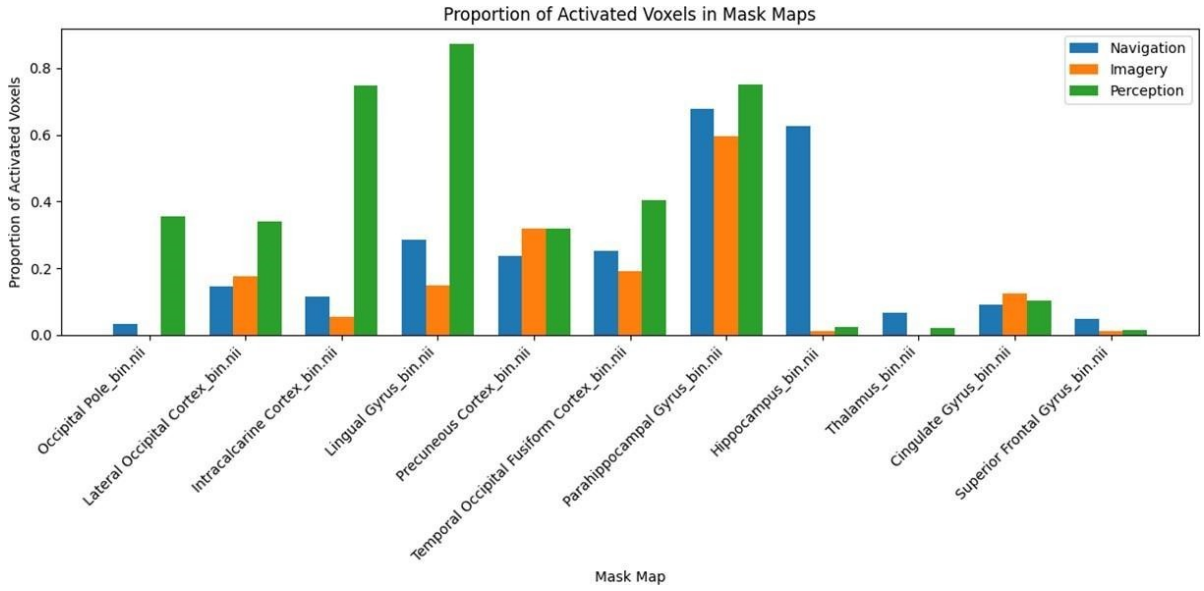

Fig.4 Proportion of activated voxels in navigation, scene perception and scene imagination map.

Discussion

The analysis of the Boccia et al. (2017) dataset on scene perception and imagery, combined with the navigational network map from meta-analyses, has revealed shared neural mechanisms underlying cognitive processes, particularly within the occipitoparietal regions and subcortical structures. Notably, the occipitoparietal region demonstrated the highest degree of overlap, reflecting its crucial role in constructing spatial representations, categorizing objects, and guiding movements during both navigation and scene perception. This region is also key for storing and retrieving spatial information, thereby facilitating effective wayfinding and the mental exploration of scenes. Our findings suggest that dynamic visual routines, such as the involuntary tracing of scenes, can be spontaneously activated by navigational affordances, even in the absence of explicit instructions to navigate. This highlights the automatic and intuitive nature of certain navigational processes. Overall, the study contributes to constructing a cognitive map of scene processing and wayfinding, advancing our understanding of the neural basis of navigation cognition in a broader context.

Navigating the Memory Maze: Cognitive Avoidance Effects on Autobiographical Memory in Healthy and Depressed Minds

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Introduction

Motivation drives behavior through internal or external cues, energizing actions toward desired outcomes (Elliot, Gable & Mapes, 2006). Central to this understanding is the hierarchical model of approach-avoidance motivation, where underlying motives energize behavior but do not inherently guide the means to achieve goals. Avoidance, defined as the tendency to evade undesirable internal experiences, plays a significant role in mental health. Cognitive avoidance strategies, such as distraction and thought suppression, are commonly employed to fend off negative thoughts and emotions,

heavily influencing various psychological disorders such as depression and anxiety (Sangui-Hanson, 2017).
Research has established that habitual use of cognitive avoidance leads to maladaptive thinking patterns, diminishing emotional engagement and detrimental to overall mental health. Positive biases in self-perception correlate strongly with good mental health, with autobiographical memories shaping these views (Debeer et al., 2011). The nature of one's recollections can impact self-worth judgments and social positioning, with goal-oriented positive memories linked to better mental health. Additionally, studies indicate that individuals with depression exhibit lower memory specificity and similar fluency across positive and negative memory domains, while healthier individuals show a clear advantage in recalling positive events (Hitchcock et al., 2020).
Furthermore, there has been theoretical evidences that illuminate the relationship between cognitive avoidance and memory processes. The Cognitive Avoidance Theory of Worry suggests that individuals use worry as a mechanism to sidestep distressing thoughts. Mowrer's two-factor theory outlines how avoidance behaviors emerge and are maintained
through conditioning, which moderately explains the persistence of maladaptive cognitive strategies. There exists a gap in understanding cognitive avoidance's mechanisms and implications on autobiographical memory, especially in differentiating between various psychological states. This study aims to investigate cognitive avoidance's influence on memory specificity and category fluency among individuals with and without depression. Hence, the findings could enhance therapeutic practices aimed at improving memory specificity and developing adaptive coping strategies. Ultimately, elucidating cognitive avoidance patterns may assist mental health professionals in refining assessment and intervention techniques, leading to better outcomes in managing distressing thoughts and emotions linked to various mental health disorders.

The study's objectives include assessing the impact of cognitive avoidance on the recall of positive versus negative memories and investigating the influence of cognitive avoidance on the specificity of autobiographical memory retrieval. The objective of the study also remains to find out if there is any relationship between cognitive avoidance and depression so as to find out if cognitive avoidance can in anyway contribute to depressive symptoms. Overall, the study aims to expand on this knowledge by investigating whether individuals practicing cognitive avoidance report similar level of specific memory recall as individuals with the symptoms of anxiety and depression.

Methods

The study involved gender-neutral participants over 25 years old, fluent in English, including both individuals diagnosed with major depressive disorder (MDD) and healthy individuals. Diagnosis of MDD and other psychiatric comorbidities was based on DSM-5 criteria, while healthy participants had no history of mental health issues and scored mildly on the Beck Depression Inventory-II (BDI-II).
A sample of 100 Indian participants aged 25-50 was selected using purposive sampling. The study employed a quasi-experimental design to examine differences in memory retrieval and emotional intensity between depressed and non-depressed individuals, with Cognitive Avoidance as the independent variable and Autobiographical Memory Retrieval (specificity and valence) as the dependent variable.
The BDI-II was used to measure depression severity, while the Cognitive Avoidance

Questionnaire (CAQ) assessed cognitive avoidance tendencies. The Autobiographical Memory Test involved recalling specific memories in response to emotional cue words. Memory specificity was evaluated based on participants' ability to provide detailed information about each event.

Procedure

The study took place in a quiet testing room with the experimenter present. It begins with participants receiving consent forms, Beck's Depression Inventory-II and the Cognitive Avoidance Questionnaire via Google form. Later, the participants will complete the Good Day-Bad Day (GD-BD) task.

The GD-BD task involves two components: first, participants will have 2 minutes to recall as many specific "good day" events as possible, defined as positive experiences from their past that occurred on a particular day or lasted less than a day. Then, the participants repeat the process for "bad days," recalling specific negative experiences under the same conditions. The participants jot down one or two words to remind them of each event, avoiding long descriptions. Afterward, they used these short notes to generate fuller descriptions of each memory. Each memory is rated for specificity (richness and temporal/spatial context).

Statistical Analysis

The data were analyzed using Jamovi for Windows, Version 2.4.14 software. A correlational analysis was used to check if cognitive avoidance and depression were correlated in anyway. Regression analysis was used to find the cause-and-effect relationship between cognitive avoidance and depression. Repeated measures ANOVA is used to compare recall of positive vs. negative memories across different levels of cognitive avoidance. $P<0.001$ was considered statistically significant in all of the analyses.

Results

Descriptives statistics showed that healthy individuals recall more good-day memories and fewer bad-day memories compared to depressed individuals.

There is a strong positive correlation between cognitive avoidance and depression levels ($p < 0.001$, $r= 0.869$). Higher cognitive avoidance is associated with higher depression scores, and this relationship is robust regardless of the correlation method used.

Regression analysis showed that for each unit increase in BDI-II scores, CAQ scores increase by 0.736 units. The intercept suggests a baseline CAQ score of 61.815 when BDI-II scores are zero. Both estimates are highly statistically significant.

Moreover, the interaction between "Memory Type" and "CAQ" is highly significant, indicating that the effect of memory type on recall depends on cognitive avoidance levels.

Discussion

Healthy individuals recall more positive memories and fewer negative ones compared to those with depression. Higher cognitive avoidance is strongly associated with higher depression levels. Regression analysis shows a significant and positive relationship between depression and cognitive avoidance. The Repeated Measures ANOVA results highlight significant effects of memory type and its interaction with cognitive avoidance, emphasizing how cognitive avoidance impacts memory recall based on memory type.

These results suggest that cognitive avoidance plays a significant role in how individuals with depression recall memories and that addressing cognitive avoidance could be beneficial in managing depressive symptoms.

The differential effects of performance contingent and non-contingent rewards on emotional distraction

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Introduction

Processing of emotional stimuli is prioritized because of their social and evolutionary value. Such prioritized processing of emotional stimuli may be detrimental in some contexts especially when the emotional information is not relevant to the task at hand. Hence, in many real-life scenarios, one must overcome potent emotional distractions to maintain successful goal-directed behaviors. Some previous work has reported that reward motivation reduces the emotional distraction during perceptual tasks (Walsh et al., 2018). To manipulate reward motivation, the authors had employed performance-based monetary rewards. In such

manipulations, apart from the *value* of expected reward, *contingency* between a successful response and reward outcome might have also contributed to the observed effects (Manohar et al., 2017). A clearer understanding of the roles of these distinct components of reward motivation in mitigating emotional distraction is of basic and clinical relevance (Grahek et al., 2019). To address this knowledge gap, we conducted a behavioural study (N=47; Age: 23.426 ± 4.358 years) to investigate how high (vs low) monetary reward prospect influences emotional distraction under performance contingent and non-contingent conditions.

Methods

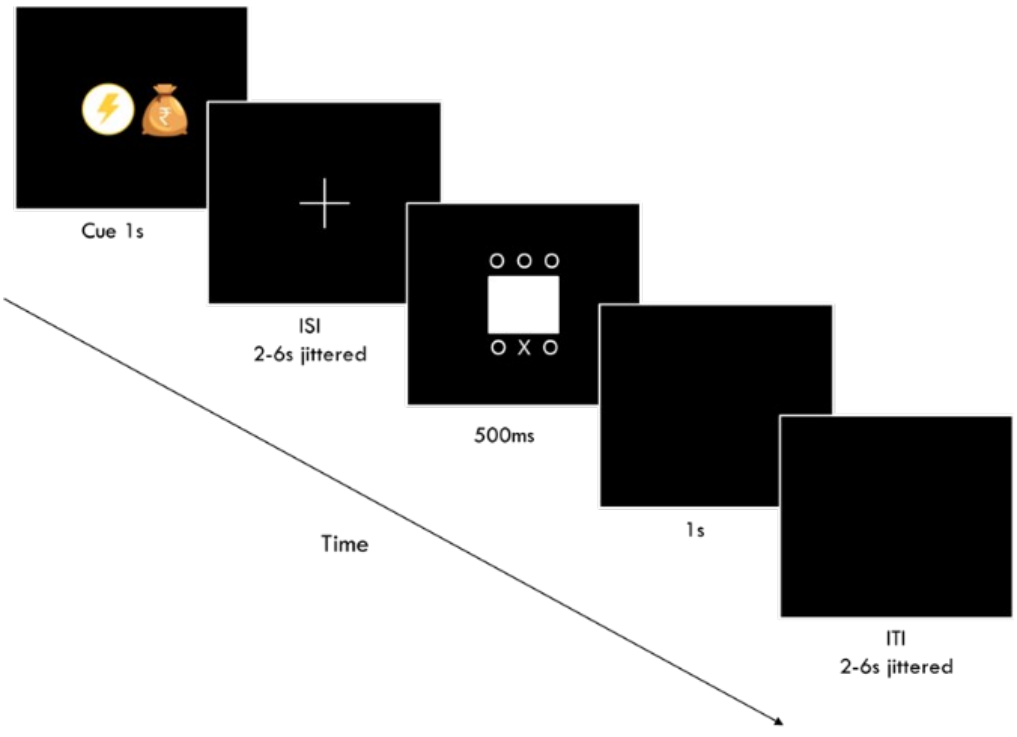
Experimental Paradigm and Design

We designed an experimental paradigm inspired by Frömer and collegues (Frömer et al., 2021) where a compound visual pre-cue indicated different reward (high vs low) levels and contingency (contingent vs noncontingent) conditions (Fig. 1). Following the cue, participants performed an 'X' or 'N' letter search task (involving low perceptual load) while trying to ignore a centrally presented positive, neutral, or negative distractor image (Fig. 1A). In the contingent trials, participants won 100 points (or 1 point) based on the high (or low) value cues if they responded *correctly and faster* than the RT threshold, which was calculated in a preceding calibration task phase performed in the absence of any potential rewards. In contrast, reward outcomes in the non-contingent trials were delivered independent of the participant's performance. Unknown to participants, probability of winning a reward during non-contingent trials was calculated based on the success rate of the preceding 10 contingent trials of the corresponding reward level. Thus, the probability of winning a reward was matched across contingent and non-contingent trials to ensure that the participant's behavior was not driven by the differences in the expected value of reward. The main experiment contained a total of 288 trials (24 per condition).

Data Analysis

A repeated-measures ANOVA was performed separately on the RT and accuracy data using 2 *Contingency* (contingent, non-contingent) x 2 *Reward* (low, high) x 3 *Emotion Distraction* (positive, neutral, negative) as within-subject factors. In the cases of significant interaction effects, follow-up analyses were performed to delineate the nature of the interaction.

(A)



(B)

Figure 1: Experimental trial structure. (A)White-colored box represents a distractor image. (B) Cues representing the reward and contingency levels. Random: *Noncontingent condition,* Performance-based: *Contingent condition*

Results

In the RT data (Fig. 2), a significant *Contingency* x *Reward* x *Emotion* three-way interaction was detected (Table 1). To understand the nature of this three-way interaction, we performed *Reward* x *Emotion* rmANOVA's separately for contingent and non-contingent conditions. During the contingent condition, a significant two-way interaction was detected ($F(2,92) = 9.731$, $p < 0.001$), which was primarily driven by the reduced negative (vs. neutral) distraction during the high (relative to low) reward conditions ($t(46) = 4.251$, $p < 0.001$). However, no difference was detected between the positive (vs. neutral) distraction between the high and low reward levels ($t(46) = 0.347$, $p = 0.73$). In contrast, during the non-contingent condition, *Reward* x *Emotion* interaction was not detected ($F(2,92) = 0.304$, $p = 0.739$) giving rise to the overall 3-way interaction.

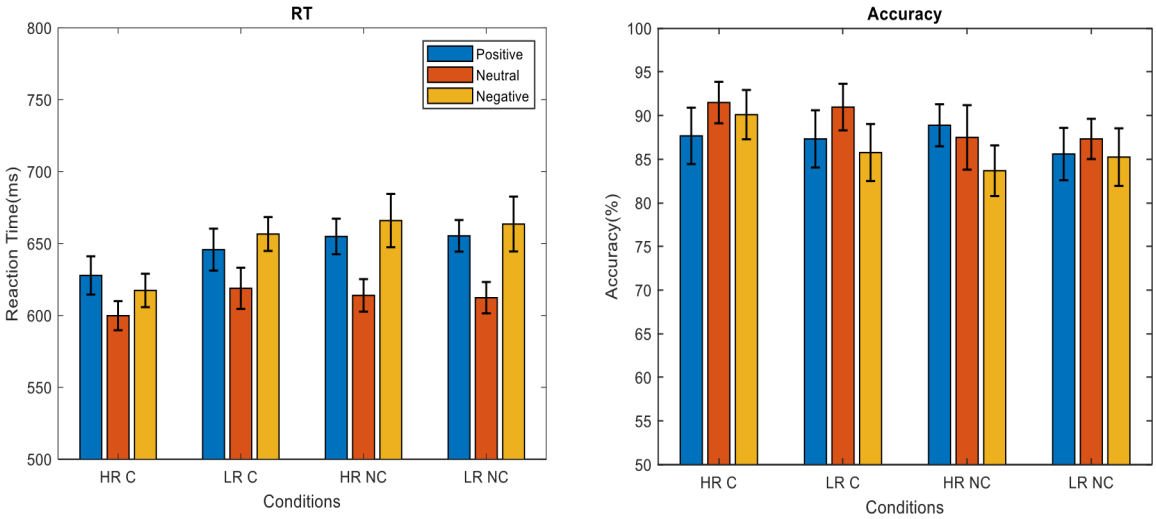


Figure 2: Mean RT across conditions. Error bars represent 95% confidence intervals. HR C: *High Reward – Performance Contingent*, LR C: *Low Reward – Performance Contingent*, HR NC: *High Reward – Non-contingent*, LR NC: *Low Reward – Non-Contingent.*

A similar three-way interaction was also detected in the Accuracy data (Table 1). Again, to understand the nature of this three-way interaction, we performed *Reward* x *Emotion* rmANOVA's separately for contingent and non-contingent conditions. During the contingent condition, a significant two-way interaction was detected ($F(2,92) = 4.209$, $p = 0.018$), which was primarily driven by the reduced negative (vs. neutral) distraction during the high (relative to low) reward conditions ($t(46) = -1.763$, $p = 0.084$). However, no difference was detected between the positive (vs. neutral) distraction between the high and low reward levels ($t(46) = 1.128$, $p = 0.265$). In contrast, during the non-contingent condition, *Reward x Emotion* interaction was not detected ($F(2,92) = 1.922$, $p = 0.152$) giving rise to the overall 3-way interaction.

Table 1**:** Repeated-measures ANOVA results of the RT and Accuracy data.

	RT			**Accuracy**		
	F	P	η^2_p	F	p	η^2_p
Main effects						
Contingency	1.377	0.247	0.029	13.628	< .001	0.229
Reward	35.535	< .001	0.436	4.284	0.044	0.085
Emotion	31.843	< .001	0.409	7.888	< .001	0.146
Two-way interactions						
Contingency ✻ Reward	12.604	< .001	0.215	3.9	0.054	0.078
Contingency ✻ Emotion	3.621	0.031	0.073	1.217	0.301	0.026
Reward ✻ Emotion	2.236	0.113	0.046	0.33	0.719	0.007
Three-way						

interaction						
Contingency ✻ Reward ✻ Emotion	4.885	**0.01**	0.096	6.187	**0.003**	0.119

Discussion

The RT and Accuracy data revealed a significant three-way interaction indicating the critical role of contingency in the reward motivation-emotional distraction interactions. Specifically, in the contingent condition, the interaction was driven by the reduced negative (but not the positive) distraction between high and low reward levels. In terms of underlying mechanisms, higher cognitive control might have been exerted to deal with the emotional distraction during the contingent (relative to non-contingent) condition leading to the observed behavioural interaction pattern. Overall, our findings indicate that contingency plays a crucial role in driving the effects of reward motivation on emotional distraction.

Facilitating moral transformation through reflection among young adults

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Abstract

Reflective thinking is believed to influence moral decision-making significantly. Greene's dual-process theory (2008, 2014) delineated between deontological and utilitarian reasoning driven by intuition and reflection. While many studies support the link between utilitarianism and reflection (Suter & Hertwig, 2011; Trémolière, De Neys, & Bonnefon, 2012; Conway & Gawronski, 2013), others challenge it (Kahane, 2012; Spears et al., 2021). Therefore, there is still a gap and uncertainty regarding the reflective-utilitarian link, and there is a dearth of research on this topic in India. This study aims to explore whether inducing reflection affects the moral judgments of Indian youth and whether different modes of reflection—individual versus group settings—produce distinct outcomes. To achieve this in the individual condition, participants completed a task-based Cognitive Reflection Test (Frederick, 2005; Primi et al., 2015) and judge the appropriateness of actions in 10 moral dilemmas with their congruent and incongruent variants (Conway & Gawronski, 2013). For the group stage, the participants are presented with five dilemmas first, following which they engage in a group discussion for the rest 5 dilemmas, and finally, they are presented with all ten dilemmas to respond privately.

Both stages are intended to foster deliberation Their utilitarian and deontological inclinations will be calculated using both traditional analysis and process-disassociation approach (Conway & Gawronski, 2013). The present study is currently in the data collection phase, with preliminary results expected by the next month. Further data analysis will be done to compare the effects of reflective thinking on moral judgments in a group-based setting vs individual.

Keywords: reflection, moral judgments, utilitarian, deontology, CRT

Session 2

Exploring the relationship of fear of happiness between anxiety, social isolation, and decision making: A mixed-method study

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Fear of Happiness—FOH, also referred to as Cherophobia, is a particular type of dysfunctional belief system in which an individual bears negative feelings and discomfort due to fear against his/her own happiness, which normally may affect mental health. (Barmanpek, 2020) Most of the traditional psychological research is focused on how happiness can be ultimately perceived as positive, but FOH explores the paradoxical that happiness can have negative consequences. (Joshanloo, 2013) FOH is associated with psychological trauma, suggesting that people who have faced trauma in their life are most likely to experience fear of happiness. This can also be seen as a type of defence mechanism that the individual develops in order to protect themselves from the future emotional pain. Literature also explains how person experiencing FOH have a positive relationship with dissociation as well. This being the initial response to the trauma, supports the initial finding

between psychological trauma and FOH (Sar et al., 2019) Cultural norms play a very important role in development of these individuals' attitude. The norms and attitudes are not just prevalent in individualistic culture but also in the collectivistic culture (Joshanloo et al., 2013). Despite the growth, the literature has very limited research in this area. Much of the literature focuses on health and wellbeing but leaves out the fear of happiness. This gap in the literature makes the need to further research the understanding of the causation and consequence of FOH even more real. Understanding FOH will be important in creating interventions that could help individuals overcome their fear in attaining a healthier relationship with their happiness. The present research will examine how FOH is related to three specific psychological constructs: anxiety, social isolation, and decision-making. A mixed-method explanatory sequential approach will be used for data collection. There are two stages of the study: the first quantitative stage in which a group of 150 young adults are asked to complete certain standardized measures. At the moment, research is in process. Included in these will be the Fear of Happiness scale, Beck's Anxiety Inventory, the UCLA Loneliness scale, and the Iowa Gambling Task, which will be delivered through Google forms and the Psychology Experiment Building Language platform (PEBL), respectively. These measures are used to assess the relationships between FOH and the other variables of interest. Continuing in the second phase, this phase is qualitative, where the 15 people will be sampled based on their scores and interviewed on the experiences of FOH; anxiety; social isolation; and decision-making in the area. Preliminary inferential statistics of 40 individuals of this quantitative phase of the study suggest that FOH and BAI scores are moderately positively correlated; that is, those who reported a greater fear of happiness also tended to report higher levels of anxiety. Secondly, it analyzes how BAI scores are a statistically significant predictor of FOH scores, suggesting that anxiety might be core in the development or maintenance of FOH. The finding is thus consistent with past literature associating FOH with other forms of psychological distress, hence portraying FOH as an important element in understanding mental health status. As such, qualitative data will be analyzed for subtleties regarding the question of how FOH is realized differently in different people and maybe to find out some underlying mechanisms that add to the fear of happiness. The objective of this stage is to complement the quantitative findings with a more indepth understanding of FOH, contextualized in terms of people's everyday experiences. Anxiety may further increase such FOH by increasing the belief in the danger or undesirability of being happy. Society could also just as readily explain FOH as being a reason for this and a result of it, where an individual fearing happiness may attempt to isolate themselves from society to avoid social interactions that may bring some kind of positive reinforcement. This can also impact decision-making, since a person fearing happiness will avoid making decisions that may result in happiness, thus avoiding growth opportunities and return from satisfaction. Given the initial findings, the qualitative phase is expected to yield results in an attempt to explain better the FOH phenomenon and its relation with anxiety, social isolation, and decision-making. Its ultimate purpose is to help in the development of effective interventions to guide individuals manage their FOH and improve their mental health and well-being. The psychological importance of FOH, as an area that is relatively under-researched, is very important since it might have important connotations for mental health. This present study was aimed at extending the understanding of FOH by relating the concept with anxiety, social isolation, and decision-making using a mixed-method approach of collecting quantitative and qualitative data. It is hoped that this study can add some useful insights that may have the potential to inform future research and clinical practice for overcoming FOH and the pursuit of a more fulfilling life.

The Role of Visual Working Memory Capacity in Autobiographical Memory Bias among Individuals with Social Anxiety Disorder

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Introduction

Social Anxiety Disorder (SAD), characterized by an excessive fear of social situations, significantly impacts individuals' social interactions, emotional well-being, and daily functioning. With a lifetime prevalence rate of approximately 13% (Szuhany & Simon, 2022), SAD is often associated with a cognitive bias towards recalling negative experiences (Rapee & Heimberg, 1997; Morgan, 2010); however, some studies have reported no such bias (Kuyken and Dalgleish, 1995). Previous research on Visual-working-memory-suggests that individuals with greater Visual-Working-Memory-Capacity (VWMC) recall more detailed memories (McKone et al., 2016). While one study has indicated that individuals with SAD may have a larger VWMC, the role of VWMC in relation-to-negative memory bias remains unclear (Jiang & Li, 2023; Moriya & Sugiura, 2012).

Objectives

This study investigates the relationship between SAD, VWMC, and autobiographical memory recall, specifically its valence and vividness. We aim to clarify the mixed findings by hypothesizing that individuals with SAD will recall a higher proportion of negative memories and that they demonstrate greater VWMC compared to controls. We also aim to explore VWMC as a potential moderator in the relationship between SAD and negative autobiographical memory bias.

Methods

The study included 29 (M=15;F=14) in SAD group and 25 (M=13;F=12) in control group and utilized instruments such as the Liebowitz Social Anxiety Scale (LSAS) to gauge social anxiety severity, the Change Detection Task on PEBL-2.1 to measure VWMC, and the Autobiographical Memory Test (AMT). The procedure involved presenting word stimuli to participants, with their responses subsequently recorded, transcribed, and rated for valence and vividness. The ratings were then evaluated for interrater reliability (r = 0.93; r = 0.62, respectively) to ensure consistency in the values of these dimensions. BDI-II was used to screen out depression. Data-collection-is-ongoing, with-a-target of 30-participants-per group-by-the-study's completion.

Results

A pronounced-autobiographical-memory-bias was observed, with significant differences in the proportion-of positive-to-negative-memories between the SAD group and controls (t = -5.01, p < 0.001, Cohen's-d = -1.29). Additionally, individuals with SAD exhibited significantly higher VWMC compared to controls (t = 3.73, p < 0.001, Cohen's d = 1.36). Furthermore, a-significant positive correlation between social anxiety scores and VWMC (r = 0.508, p < 0.001) suggests that higher levels of social anxiety is linked to higher VWMC. Negative memories were significantly more vivid in the SAD group (M = 8.137) than in controls (M = 6.706), showing a significant group difference (p < 0.001, Cohen's d = 0.6483). But no significant difference in overall memory vividness between groups (p = 0.103). Additionally, positive memories were generally more vivid than negative ones across both groups (p < 0.001, mean difference = 0.84, Cohen's d = 0.532). Moreover, a significant positive correlation was found between VWMC and the vividness of negative memories (r = 0.32, p < 0.01) in both groups, though this correlation did not extend to positive memories.

The lack of a significant correlation between VWMC and overall memory vividness (p = 0.084) may be attributed to the smaller sample size. Social anxiety (R^2 = 0.296, β = 0.0205, p < 0.001) and VWMC (R^2 = 0.121, β = 2.57, p = 0.010) both predicted negative memory vividness, with the interaction between SAD and VWMC significantly predicting memory vividness (R^2 = 0.276, β = 0.0220, p < 0.001).

Discussion

Existing research on WMC in SAD has yielded mixed results, with studies reporting both reduced (Amir et al., 2008) and elevated (Moriya & Sugiura, 2012) WMC.

This study, however, demonstrates a significantly higher WMC in individuals with SAD, with a large effect size, highlighting the need for further investigation to understand the WMC and SAD relationship better. The study also reveals a significant autobiographical memory bias in individuals with SAD, characterized by a higher number of negative memories recalled than positive ones and compared to controls. But the hypothesized moderation relation is not statistically supported. Additionally, while-positive-memories-were-more-vivid-thannegative-ones-in-both-groups, individuals-with-SAD-exhibit-greater-vividness-in-recallingnegative-

autobiographical-memories-compared-to-positive ones. This enhanced vividness, facilitated by higher VWMC observed in SAD individuals, may enable more vivid recall and rumination on negative experiences with greater clarity and contribute to the maintenance and amplification of social anxiety. This finding is consistent with the cognitive model of anxiety, which posits that enhanced cognitive processing capacity can exacerbate the focus-on-andretention-of-threatening-information (Beck & Clark, 1997; Hirsch & Mathews, 2012).

Conclusions

These findings indicate that VWMC plays a role in the negative memory bias seen in SAD, with significant implications for understanding the cognitive mechanisms underlying the disorder. The relationship between VWMC and the vividness of negative memories suggests that targeting VWMC through cognitive training or attentional bias strategies could reduce this vividness, offering a promising therapeutic approach. Future research should explore the causal relationship between VWMC and negative memory recall and examine the neural mechanisms involved via neuroimaging.

Keywords. Social Anxiety Disorder, Visual Working Memory, Autobiographical Memory Bias, Cognitive Bias, Autobiographical Memory Task

Effect of environmental value orientation framing on pro-environmental behaviour intentions using motivated attention framework: An eye-tracking study

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Introduction

One important persuasion strategy psychologists study is the framing effect, which greatly impacts people's attitudes and behaviours. Whether to present information as a gain or a loss frame can influence how decisions are made (Kahneman & Tversky, 1984). According to Shan et al., (2022), research shows that pro-environmental behaviors, like buying organic food, are especially effective when they are presented in a loss-framed manner. Nilsson et al., (2016) found that framing effects might not have as much of an impact on significant decisions because attitudes and behaviours tend to hold steady over time. The tailoring approach, which involves matching information with a person's interests and needs, was developed by psychologists to get around this limitation (Nilsson et al., 2016). Research demonstrates that people process value-congruent information more methodically, which can result in framing bias (von Borgsteade et al., 2014). According to Walsko et al. (2016), the tailoring strategy has successfully encouraged environmental behaviours in various settings.

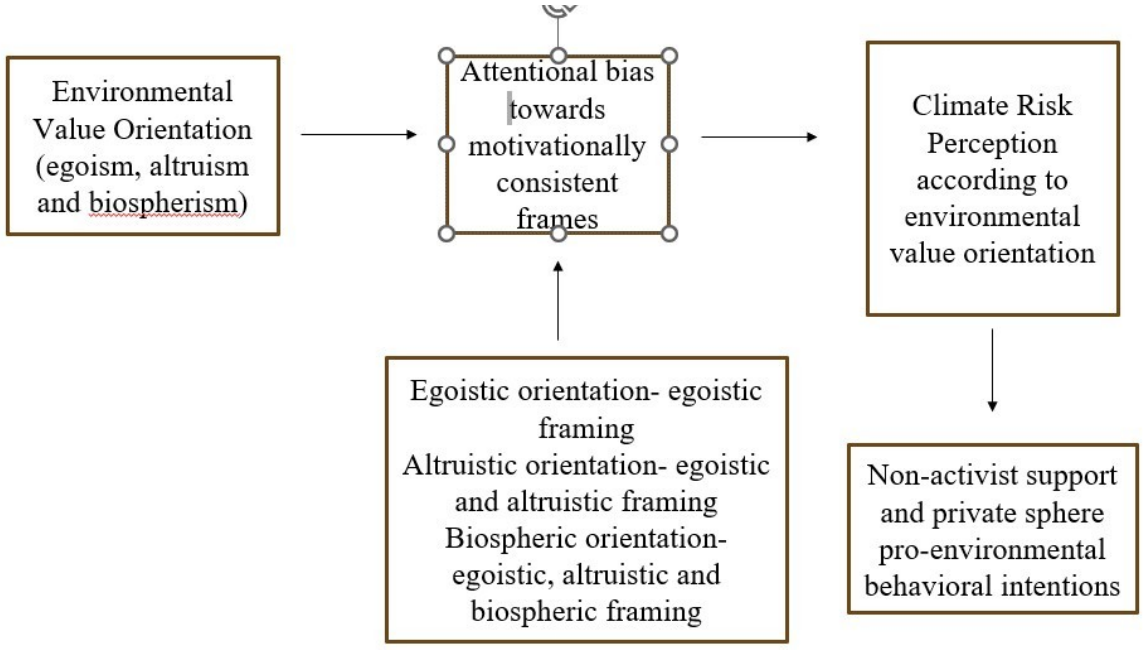
The effects of framing based on environmental value orientation on different proenvironmental behavioral intentions have been previously studied in environmental psychology settings (Hansla, 2010; von Borgstede, 2014). Notably, using the Inclusion Model of Environmental Concern (IMEC), De Dominiscus et al. (2017) evaluated whether people with various environmental value clusters accept value-congruent frames. According to this model, people with altruistic orientations interact with both egoistic and altruistic frames, whereas people with egoistic value orientations respond mainly to egoistic frames. The study found evidence supporting the IMEC theoretical framework, which resulted in proenvironmental behaviors. On the other hand, people who identify as biospheric are probably going to react to any kind of frame, including that of a biospheric frame.

Additionally, studies using the motivated attention and reasoning approach (Luo & Zhao, 2020) show that ideologies influence how people perceive climate risk and how they intend to protect the environment (Newman et al., 2018; Whitman et al., 2018). There are, however, insufficient studies assessing attentional bias in experiments involving framing that take environmental value orientation into account.

Furthermore, little research has been done on how different types of climate risk perceptions (Personal, Societal, and Global Climate Risk Perceptions) can align with the attentional bias given to the environmental value orientation frames. Furthermore, little research has been done on the connection between pro-environmental behavior—particularly public versus private actions—and different types of climate risk perceptions.

Therefore, the problem at hand is the paucity of thorough research on how egoistic, social, and biospheric values shape people's attention to motivationally consistent frames of the consequences of climate change. This knowledge gap makes it difficult to comprehend how various value orientations influence how people perceive climate risks and process information, which affects how they behave.

Therefore, the present study aims to integrate the model of Motivated Attention Framework and the Inclusion Model of Environmental Concern along with research findings that explore the relationships between different types of climate risk perceptions and proenvironmental behavior.



Method

Sample:

The study is conducted in two main phases: the Questionnaire Phase and the Eyetracking Phase. Two pilot studies comprised the questionnaire phase study: Pilot Study 1 involved 32 participants for receiving feedback regarding the Pro-Environmental Behavioral Intentions Scale, and Pilot Study 2 involved 332 participants for the standardization of the

Climate Risk Perception Index, Environmental Value Orientation and Pro-Environmental Behavior Intentions Scale. Pre-pilot and Pilot studies comprised of 4 and 3 participants will be used for the eye-tracking phase study to assess the quality of the stimuli, and the main study will comprise thirty participants, all between the ages of 18 to 35. Purposive, convenience, and snowball sampling was employed to reach the participants. The participation inclusion criterion includes participants who are proficient in English, who share the age group of 18 to 35, and who don't have psychological disorders and physiological problems related to vision, neck, or spine.

Design and Procedure

The study follows a cross-sectional design and a quasi-experimental approach. The study employs the Eyelink 1000 Plus Eye-Tracking system to investigate attentional bias in response to texts depicting the consequences of climate change. Participants were made to see 15 trials conveying the incomplete climate change consequences message without a time limit which was followed by 3 boxes mentioning "you", "other people", and "animals and birds" simultaneously for 11 seconds. The study takes place at the NeuroCognition Laboratory, Christ University, Bengaluru.

Tools Used during the eye-tracking phases Include the Environmental Value

Orientation Scale (Schultz et al., 2005), the Newly Created Pro-Environmental Behavioral

Intentions Scale, and the Climate Risk Perception Index (Leiserowitz, 2006). The Climate Risk Perception Index has been adapted to include other dimensions like food scarcity, and heatwaves along with other dimensions which include holistic concern, perception of water scarcity, prevalence of diseases, and standard of living in the future. The newly created Pro-

Environmental Behavioral Intentions Scale is based on the theoretical framework by Stern (1999). During the Questionnaire Phase Study, the questionnaires were administered nationwide via Google Forms for validation purposes. All the participants gave their Informed Consent before participating in the Questionnaire Phase Studies and the eyetracking phase studies.

Statistical Analysis

For statistical analysis, the study will make use of Jamovi software. Correlation analysis will evaluate relationships between eye tracking parameters (fixation count, dwell time, revisits, and first to fixation on AOI), different climate risk perceptions, and proenvironmental behavioral intentions. ANOVAs (One-way ANOVA, mixed-model ANOVA, and three-way ANOVA) will be used to investigate how environmental value orientation and attentional bias affect different climate risk perceptions and pro-environmental behavioral intentions. Structural Equation Modeling (SEM) was conducted to establish the validity and reliability of the questionnaires- Climate Risk Perception Index, Environmental Value Orientation Scale, and Pro-Environmental Behavior Intentions.

Results

Structural Equation Modeling was conducted to check the validity and reliability of the Climate Risk Perception Index and Pro-Environmental Behavioral Intentions. The Climate Risk Perception retained the three factors namely Personal, Societal, and Global Risk

Perception with an excellent data fit of the model ($\chi 2$= 231, df=34, CFI= 0.985, TLI=0.976, SRMR=0.071, RMSEA=0.041) (Bentler, 1990). The scale and its subscales achieved good to excellent reliability ranging from 0.77 to 0.92.

The Pro-Environmental Behavioral Intentions Scale retained the two factors namely Public and Private Pro-Environmental Behavioral Intentions with an excellent data fit of the model ($\chi 2$= 63.1, df=31, CFI= 0.984, TLI=0.982, SRMR=0.051, RMSEA=0.051) (Bentler, 1990). The Scale and its subscales achieved acceptable to good reliability ranging from 0.63 to 0.83. The convergent validity of both the scales was established (Fornell & Larcker, 1981). The reliability of the Environmental Value Orientation Scale and its subscales achieved excellent reliability ranging from 0.92 to 0.96.

The pre-pilot study of the Eye-tracking phase is in progress, so the statistical analysis for this phase is not done yet. However, the expected results are that the environmental value orientation influences the attention to frames that depict each kind of environmental value orientation, which in turn influences different kinds of climate risk perception and proenvironmental behavioral intentions.

Attribution, JTC Reasoning and Social Threat Perception in Individuals with Paranoid Ideations and the Mediating Role of Interoceptive Sensitivity

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Paranoia is the general feeling of mistrust and suspicion in others. It occurs due to a combination of cognitive biases and co-occurring emotional processes like anxiety, depression and self-esteem (Bentall et al., 2009). Paranoid ideations, more characteristic of psychotic illnesses, occur as a continuum and range in frequency from less than 2% to nearly 30% in the community samples (Bebbington et al., 2013). Examining subclinical presentations may aid the understanding of transitions into a clinical level of paranoia that is distressing or interferes with one's functioning. There have been no studies in the Indian population addressing this issue.

People with paranoid ideations are shown to have biases in their attributional style, Jumping-to-Conclusion (JTC) reasoning and social threat perception. This further leads to biased information processing and fosters paranoia. Individuals with paranoid thinking at a subclinical level may also endorse these biases to some extent. Mental processes depend upon a dynamic integration of brain and body. Emotions encompass internal physiological changes underpinning emotional feelings through Interoception (Garfinkel & Critchley, 2015).

Interoceptive Sensitivity (IS) is likely to be associated with the development of paranoid ideations, owing to its role in modulating self and emotion regulation and processing.

An ex-post facto research design was employed where sixty people without a clinical disorder diagnosis will be administered the Internal, Personal and Situational Attributions Questionnaire (IPSAQ) (Kinderman & Bentall, 1996), Beads task or Probabilistic Reasoning task (Huq et al., 1988), Social Threat Perception (STP) Task, Green et al. Paranoid Thoughts Scale (GPTS) (Green et al., 2008), and the Mental Tracking Method in Heartbeat Detection task (HDT). This ongoing study aims to determine the relationship between attribution, JTC reasoning, social threat perception and Interoceptive Sensitivity to the level of paranoid ideation in a non-clinical population. Also, the study aims to examine if interoceptive sensitivity plays a mediating role in the relationship between attribution, JTC reasoning, and social threat perception and paranoid ideations.

The findings from the preliminary data analysis show interesting trends but the work is still in progress. Analysis was done using the Jamovi software with data from 22 participants to determine the descriptive of the population and the variables and investigate the trends seen in the data. Shapiro-Wilk Test for Normality indicated that data was normally distributed for Age, Externalising Bias (EB) and Personalising Bias (PB) in IPSAQ, time taken to identify threatening and non-threatening stimuli in STP, GPTS and IS in HDT but not for average Drawsto-Decision (DTD) in the Beads Task and time taken for identifying neutral stimuli in STP.

The mean age of participants was 21.9 years (SD = 2.02), and the minimum and maximum ages were 18 and 25 years, respectively. The mean score for paranoid ideations on the GPTS was 65.7 (SD = 25.2), with a minimum score of 37 and a maximum score of 129, highlighting the spread of paranoid ideations in the non-clinical population. The sample had a 36.4% prevalence of JTC reasoning, indicating that this cognitive bias is present in a significant subset. Differences were seen in the time taken to identify threatening and non-threatening facial expressions on the Social Threat Perception task. The mean index score on HDT for Interoceptive Sensitivity (IS) was 0.441 (SD = 0.278). A higher score indicates a higher IS. The minimum and maximum scores on this were 0 and 0.893, respectively. Further, a lower average DTD on Beads Task was associated with people with a higher IS, which suggests that people with JTC reasoning have higher IS. Gender was also associated with JTC reasoning, which showed that women tend to endorse JTC bias more than men. Age was also positively associated with the attributional style EB, indicating that it increases with age.

The continuum of paranoia has significance for the aetiology, mechanisms and treatment of clinical disorders. Given that paranoid ideation may precede delusion formation, our understanding of delusions may be enhanced by studying paranoid thinking in non-clinical populations (Bebbington et al., 2013). Misinterpreting interactions and events will affect daily functioning, including emotional well-being and mental health.

Keywords: Paranoia, attributional style, jumping-to-conclusion reasoning, social threat perception, interoceptive sensitivity, non-clinical population

Exploring Ethical Decision-Making in Driving Dilemmas: A Mixed Methods Study

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Introduction

Navigating ethical decisions on the road involves more than just following traffic laws or calculating risks; it requires a deep understanding of the moral principles that guide our actions. This study delves into the complex nature of ethical decision-making in driving, exploring how drivers incorporate virtues like compassion, justice and fairness alongside traditional ethical frameworks such as utilitarianism and deontology. By examining the role of virtue ethics in drivers' decision-making during ethical dilemmas, this research aims to provide a more nuanced understanding of how these moral principles influence real-world decisions. Understanding how human drivers balance these ethical approaches can offer valuable insights into the ethical programming of AVs.

The significance of this research lies in its potential to bridge the gap between traditional ethical theories and virtue ethics in the context of driving. Ethical dilemmas, such as choosing between the safety of passengers and pedestrians, pose significant challenges not only for human drivers but also for the designers of AVs. By exploring the role of virtue ethics, this study seeks to inform the ethical programming of AVs, ensuring they reflect human values

and ethical reasoning. While previous studies have often focused on utilitarian and deontological approaches, this research emphasizes the importance of virtue ethics in real-world driving scenarios. By examining how drivers navigate these dilemmas, this study aims to enhance our understanding of ethical decision-making in driving, with implications for both driver behaviour and the future of automated transport systems.

Ethical decision-making in driving has traditionally been studied through the lens of utilitarianism and deontology. Utilitarian approaches prioritize minimizing overall harm, as seen in research by Li et al. (2019) and Samuel et al. (2020), where decisions are based on the greatest good for the greatest number. Deontology, on the other hand, emphasizes the importance of following rules and principles, regardless of the consequences. However, these frameworks may not fully encompass the complexities of human moral reasoning, particularly in situations where virtues such as compassion and fairness are at play. The development of AVs has further complicated this landscape, as these vehicles must be programmed to make ethical decisions that align with societal values. Unlike fixed algorithms, machine learning allows AVs to adapt to different situations, making virtue ethics a potentially valuable framework for their behaviour (Liao et al., 2019). Studies of simulated driving scenarios reveal that while participants often adopt a utilitarian approach, their decisions are also influenced by factors such as the perceived severity of injuries and the lifespan of avatars in the simulation (Faulhaber et al., 2018). This suggests that ethical decision-making in driving involves a combination of different ethical approaches.

Methods

This study employs a mixed-methods approach to explore ethical decision-making in driving scenarios, combining quantitative and qualitative data to understand participants' ethical reasoning comprehensively. Participants were recruited based on specific inclusion criteria, including holding a valid driver's license and being within 18-55 years. So far, the sample consists of 70 participants ($M = 25.45$, $SD = 8.47$).

The study uses a computerized task in PsychoPy, presenting participants with six driving scenarios depicted through images. They are required to make decisions using designated key presses, such as the space bar for sudden stops and the right arrow key to swerve right. Following the task, participants complete a post-task questionnaire to elicit qualitative insights into their decision-making processes. This questionnaire includes open-ended questions to understand the ethical principles that guided their decisions. Quantitative data from the decisions made during the task are analyzed to identify trends in ethical reasoning, while qualitative data from the questionnaire are subjected to thematic analysis to uncover the underlying ethical frameworks employed by participants.

Results

Preliminary analysis of the six driving dilemma scenarios shows a strong preference for sudden stopping to avoid collisions with pedestrians, cyclists, and children, even when this increases the risk of a rear-end collision. In Scenario 1, where a pedestrian suddenly crossed the road, 58.6% of participants chose to stop suddenly, prioritizing the pedestrian's safety over their own. This trend suggests a significant inclination towards protecting vulnerable road users, aligning with utilitarian and virtue ethics principles.

The thematic analysis of participants' responses reveals a blend of ethical approaches. Utilitarianism is evident in statements such as "It is better to hit a car or let a car collide with you rather than risking a life," highlighting the emphasis on minimizing harm. Deontological perspectives are also present, with some participants stating, "I always follow the rules of driving in all situations." However, virtue ethics is prominently reflected in responses like "I

did not want to hurt others. It is not fair," indicating that personal values and compassion significantly influence decision-making.

Discussion

The findings of this study suggest that ethical decision-making in driving scenarios is multifaceted, involving a combination of utilitarian, deontological, and virtue ethics. The strong preference for sudden stops to protect vulnerable road users indicates a prioritization of safety and compassion, even at the expense of personal risk. This blend of ethical frameworks suggests that drivers navigate complex moral choices by integrating various approaches, reflecting the nuanced nature of human ethical reasoning.

The implications of these findings extend beyond human driving behaviour to the ethical programming of AVs. As AV technology advances, ensuring that these vehicles can make decisions that align with human values and ethical principles will be crucial for their widespread acceptance and safety. This research contributes to the ongoing discourse on how best to integrate virtue ethics into the ethical frameworks that guide AV behaviour, ensuring that they are safe and ethically sound. In conclusion, the study highlights the importance of incorporating multiple ethical perspectives in human and automated driving.

Annotation of Silent Pauses in Emotional Narratives under Gesture Restrictions

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Introduction

The role of silent pauses and gestures in emotional narratives is multifunctional. These articulators are responsible for the pragmatic, semantic, and temporal organization of the speech and represent the internal cognitive processes. Silent pauses considered a hesitation or disfluency marker, have been studied from various perspectives and disciplines (Ephratt, 2022) and hold a rather significant role in an emotional context (Levitt, 2001). Gestures' effect on speech disfluencies, including silent pauses, has been accepted and, more recently, refuted (for a detailed review, refer to Cravotta et al., 2021) in a series of investigative experiments. Although there is a field of research on the impact of gesture restrictions on speech disfluencies in fictional narratives, no research has yet considered the effects of gesture restrictions on speech disfluencies, particularly silent pauses in personal emotional narratives.

Embodied emotion theorists propose that processing emotional information involves re-experiencing the relevant emotion in one's self (Niedenthal et al., 2005). The multimodal nature of the emotional narratives from the past consists of various episodic elements (events,

actions, people, sensory-perceptual information) (Conway, 2001), unprocessed emotions (Gross & Levinson, 1993), and an attached meaning of self and the world. A recent study found a link between gesture production and episodic information units (Aydin et al., 2023). Other studies have found that emotionally negative stories are more memorable than positive or neutral (Van Bergen, Wall, & Salmon, 2015), and there is a tendency to produce more gestures when retelling negative than positive stories (Ozder, Ozer & Goksun, 2023). The gesture-speech link in multimodal communication has been empirically investigated on many levels; however, non-verbal emotion communication remains an understudied area of research (Asaligolu & Goksun, 2023).

The present study aims to investigate the distribution of silent pauses (i.e., frequency and duration) in the monologue emotional narratives using a standard and prevalent gesture restriction method and report these findings. This study will shed light on the relationship between gesture and speech in the emotional context.

Methods

Seventy university students (M = 30; mean age = 22.7, range = 19-23) volunteered to participate in the study. They were divided into the restricted gestures group (35) and the non-restricted gestures group (35). Each participant was instructed to narrate two kinds of personal narratives: a daily routine (NEm) and an emotional incident (Em based on fear, anger, or sadness) in a quiet room on a Sony Camcorder. The experimenter was not present in the room during the narration. The order of the narratives was randomized to prevent any order effects. The participants were free to use the language of their choice. All the narratives were either in Hindi, English, or Hindi-English Mixed Code. A physiological sensor was put on the wrist to prevent participants from gesturing in the Gesture-Restricted Group, and palms were taped to the desk (Fig. 1).

Fig. 1. Experiment Setup (Gesture-Restricted Group)

Results

Silent pauses were manually annotated using ELAN 6.7 into the three length-based categorizations by two coders. For an in-depth temporal marker in both the conditions and the groups, silent pauses were categorized into brief (250ms-500ms), medium (500ms–1s), and long pauses (more than 1s). The following results are based on preliminary data (n = 16) and are only indicative of the larger dataset. A mixed-effects linear regression model was applied in the study to measure the effects of restrictions, gender, and language.

- An increase in the occurrence of medium and long pauses was observed in the restricted group at a 0.5 level of significance.

- A significant number of medium pauses were observed in females, while more long pauses were observed in males.
- Medium pauses were significantly higher only in the emotional condition in the restricted gestures group.
- A significant difference was observed in the speech rate, indicating that Em speech was more prolonged than NEm speech in both the restricted group (0.01 level of significance) and the Non-Restricted group (0.1 level of significance).
- A Hindi-English Mix dataset observed a significant increase in brief pauses.

- Overall, the effect of the restricted group was observed in the occurrence of brief, medium, and long pauses.

Discussion

This study categorized silent pauses based on length for an in-depth study of this variable within the emotional narratives under gesture restrictions. Gestures, silent pauses, and emotional narratives have a three-fold relationship, each holding a significant role in efficient multimodal communication. The preliminary results indicate substantial differences in both the groups and the two conditions. Language and gender also influence the frequency of silent pauses in this context. The implications of these findings may prove significant, particularly in the development of AI Audio-Video psychotherapeutic chatbots. Further, a deeper understanding of the relationship between gestures and other speech disfluencies may offer valuable insights for enhancing psychotherapy and educational practices.

Note: The participant granted permission to use the image (Fig. 1) in reporting findings and publications.

Mapping the Circumplexity of Personality Metatraits, Schwartz's Values, and Trait Mindfulness in Indian Adults: A Principal Component Analysis Approach

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Introduction

The study aims to examine the circumplex structures of personality, values, and mindfulness, measured by the Big Five Inventory (BFI), Revised Portrait Value Questionnaire (PVQ-RR), and the Five Facet Mindfulness Questionnaire (FFMQ) (Baer et al., 2006; Schwartz, 2012; Strus et al., 2014) to validate their circumplexity and elucidate the interconnectedness of their constructs. Schwartz's theory of refined values uses a circumplex model to illustrate the compatibility or conflict among ten basic values (PVQ-10) and nineteen narrowly defined values (PVQ-19) based on their spatial proximity on a circular continuum. Values situated close to each other share similar motivational goals, whereas those opposite each other exhibit significant conflict. Similarly, the BFI, based on Goldberg's model (Goldberg, 1990) outlines five orthogonal dimensions of personality—Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness, from which four higher-order traits were identified—Alpha, Beta, Gamma, and Delta, and organized within the Circumplex of Personality Metatraits (CPM), a circular structure with four bipolar meta-traits and eight unipolar constructs (Strus et al., 2014). The FFMQ measures mindfulness' five facets—Observation, Description, Actawareness, Non-Judgment, and

Non-Reactivity—illustrating their interrelations within the broader construct of the mindfulness framework. However, for the FFMQ, an apriori study has suggested merging some of its dimensions as observing with non-reactivity (Lecuona et al, 2021). The dimensional investigation of these crucial socio-psychological constructs is critical for understanding the dynamic and relational elements of their psychological conceptions, as well as improving theories of mind and behavior within the context of cognitive science.

Methods

580 university students (291 women) (M = 22.5 years, SD = 4.45 years) were recruited through purposive snowball sampling as they completed the BFI, PVQ-RR, and FFMQ questionnaires. The study received approval from the Institute Ethics Committee of the Indian Institute of Technology, Delhi. (IEC-IITD; Proposal No. P021/P0101). Raw scores from the BFI and centered scores from the PVQ-10, PVQ-19, and FFMQ were subjected to PCA using the snowCluster module via Jamovi to reduce dimensionality and visualize the circumplex structures. Further, the CPM model was applied to BFI's five-factor model apriori, obtaining orthogonal dimensions Alpha (Stability) and Beta (Plasticity), along with Gamma (Integration) and Delta (Self-Restraint).

Results

The results supported the circumplex models for the BFI, PVQ, and FFMQ. For the BFI-derived metatraits (Fig.1), three principal components were identified. The first component explained 63.05% of the variance, the second 33.10%, and the third, although with an eigenvalue less than 1, accounted for 3.86% variance. The analysis of the PVQ-RR values was akin to the theorized model. The PVQ-10 (Fig.2) had five components with eigenvalues greater than one, with the first component explaining 24.17% of the variance, followed by 17.80% and 11.73% for the second and third components, respectively. PCA for PVQ-19

(Fig.3) revealed seven components with eigenvalues greater than one, with the first three components accounting for 14.86%, 12.43%, and 8.09% of the variance, respectively. Two components were reported to be significant with the FFMQ (Fig.4), the first accounting for 44.94% of the variance and the second explaining 24.37% of the variance.

The PCA visualizations reinforce these findings as the CPM model's orthogonal dimensions demonstrate a circular arrangement of personality metatraits. Likewise, the PVQ-RR results exhibit the expected circumplex structure, wherein the values are positioned according to their motivational affinities and conflicts. The FFMQ's components provide insights with Observation and Non-reactivity as opposing facets to Actawareness and Non-judgement, with the Describing facet remaining adjacent.

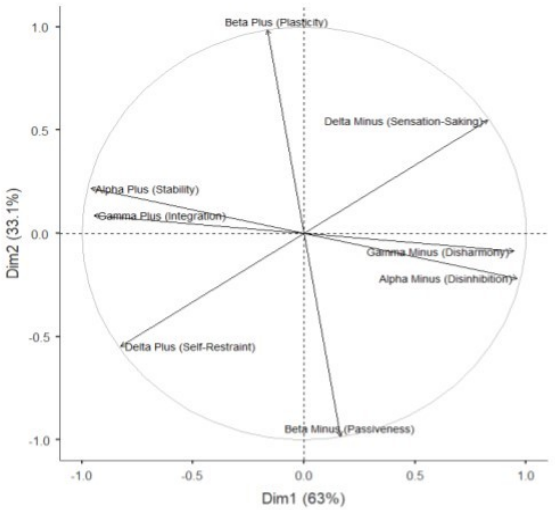

Fig.1 BFI Metatraits PCA Analysis

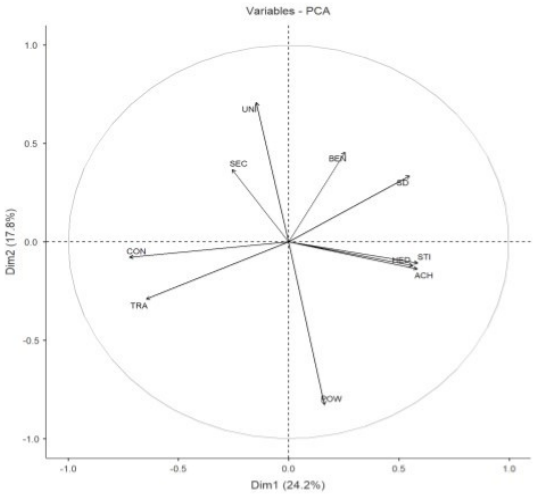

Fig.2 PVQ-10 PCA Analysis

Note: UNI-Universalism; BEN-Benevolence; SD-Self-Direction; ACH-Achievement; STI-Stimulation; HED-Hedonism; POW-Power; TRA-Tradition; CON-Conformity

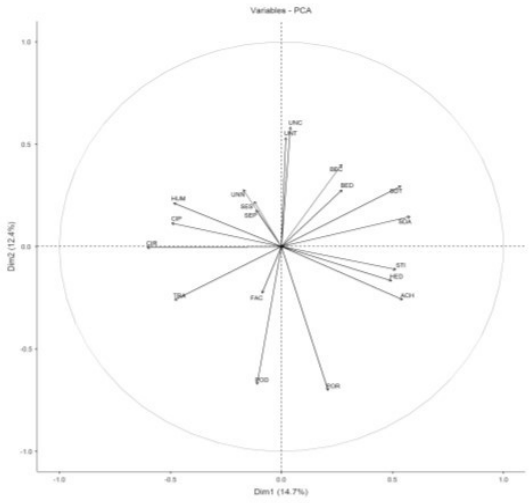

Fig.3 PVQ-19 PCA Analysis

Note: UNN-Universalism-Nature; UNC-Universalism-Concern; UNT-Universalism-Tolerance; BED-Benevolence-Dependability; BEC-Benevolence-Care; SDT-Self-Direction Thought; SDA-Self-Direction Action; STI-Stimulation; HED-Hedonism; HUM-Humility; ACH-Achievement; POR-Power-Resources; POD-Power-Dominance; FAC-Face; TRA-Tradition; CIR-Conformity-Rules; CIP-Conformity-Interpersonal; SES-Security-Societal; SEP-Security-Personal.

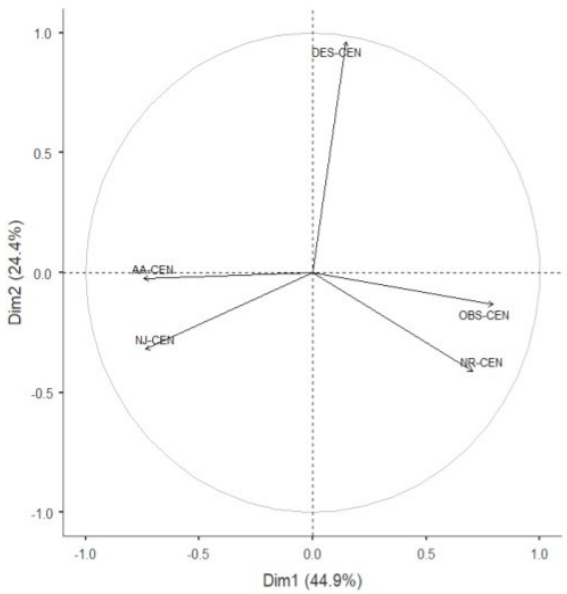

Fig.4 FFMQ PCA Analysis

Note: DES-Describing; OBS-Observing; NR-Non-Reactivity; NJ-Non-Judgement; AA-Actawareness.

Discussion

The study advances the understanding of circumplex models for personality, values, and mindfulness, wherein their replication underscores robustness toward culturally multifaceted psychological data. The BFI-derived metatraits, as arranged within the CPM, highlight the interplay between stability, plasticity, mental health, and behavior control, aligning with the theoretical model (Strus et al., 2014). The circumplex structures of PVQ-10 and PVQ-19 also confirmed Schwartz's theory (Schwartz & Cieciuch, 2021), with minor variations regarding the positioning of Benevolence and Security values, which may suggest a cultural emphasis on independent social behavior and a stronger association with social harmony-stability rather than personal or societal status. The placement of FFMQ's facets in the circumplex model contrasts non-judgmental, active mindfulness with detached observation and passive mindfulness and links verbal expression to mindful awareness and active observation, thereby underscoring the need to consider these facets interactively in mindfulness practices. Such insights are valuable in enriching nuanced assessments of personality and value-based therapeutic practices, supporting the utilized self-report questionnaires for addressing complexities of behaviors, attitudes, and cultural variability.

Investigating Neural Activity in a Recurrent Network: Insights from Simulating a Go/No-Go Task

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Understanding decision-making mechanisms is vital in neuroscience. We present a computational model using recurrent on-center off-surround neural networks to simulate neural activity in go/no-go tasks (Simmonds et al, 2008). The beta parameter in our model represents lateral inhibition, a key factor in neural processing. Previous research indicates that successful enumeration of small (subitization) and large (estimation) numerosities requires high and low inhibition, respectively (Sengupta et. al, 2014, Verma and Sengupta, 2023).

Using signal detection theory (SDT), we analyze the model's output, focusing on hit and false alarm rates to assess performance. Our model systematically explores the impact of beta across different input stimuli configurations, revealing its influence on neural activity. By calculating mean neural activity, hit and false alarm rates, and their corresponding z-scores, we showcase the model's sensitivity and specificity.

Furthermore, we examine the integration of executive functions and enumeration in human perception, offering insights into how cognitive processes shape neural dynamics during decision-making tasks. Our findings advance the understanding of the neural basis of cognitive processes, emphasizing the role of lateral inhibition in successful enumeration across varying numerosity ranges.

We also checked the model predictions with behavioral experiments. Experiment 1, participants initially adapted to a reference numerosity of N=13 . Subsequently, they compared displayed numerosities to this reference, responding accordingly. Trials were divided into conditions where either smaller or larger numerosities served as go or no-go stimuli (Smallgo and Largego). Results showed no discernible difference between Smallgo and Largego conditions across blocks. Experiment 2 removed the adaptation block, focusing on two numerosity sets: small (≤5) and large (>11). Again, participants responded to go or nogo stimuli based on numerosity, revealing a significant main effect between Smallgo and Largego conditions. Notably, participants exhibited higher d' values (indicative of better discrimination ability) in Smallgo conditions compared to Largego conditions. The findings follow the simulations closely.

Parenting now and then: An Intergenerational Analysis of Perceived Parenting in Young Adults and Middle Age Adults

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SR University

Generational shifts in parenting practices show that parenting has evolved over time due to changes in societal, cultural, and economic contexts. Understanding the differences in perceived parenting across generations is essential for capturing these shifts and comprehending the factors that contribute to changes in parenting behaviors and attitudes. Researchers have studied how harsh parenting can be passed down through generations. (Simons et al, 1991) Other studies have examined how a mother's and child's anxiety can affect each other, especially during major traumatic events. (Yirmiya et al, 2021) There has been research on how different parenting styles, along with social support, relate to mental wellbeing. (Lavasani et al, 2011).

The study explores how societal and cultural shifts influence perceptions of parenting across generations. It examines the differences in how young adults and middle-aged adults perceive the parenting they received, aiming to identify the factors contributing to these perceptions and any significant differences between the two age groups. The qualitative research design employs semi-structured interviews with a sample of 24 participants, comprising both young adults and their parents. The young adult participants, aged between 22 and 29, are selected through a purposive sampling strategy. The middle-aged adult participants, aged between 40 and 65, are chosen based on the criterion that they are the parents of the selected young adults. The interview questionnaire consists of 16 questions that explore various domains related to parenting, including general perceptions about parenting, emotional attachment, selfexploration, parental influence, experiences of trauma, power dynamics, and the negative aspects of parenting. The data collected from these interviews are analyzed using content analysis to gain insights into these complex dimensions of parenting.

The results revealed distinct perceptions of parenting between middle-aged adults and young adults. Middle-aged adults often viewed their fathers as strict and emotionally distant, while mothers were perceived as nurturing and affectionate. Parenting in their era was more focused on providing material resources than on individualized care, with emotional bonds generally stronger with mothers. Despite recognizing some negative traits in their parents, such as emotional reservation and excessive strictness, middle-aged adults generally viewed their upbringing positively. Similarly, young adults described their fathers as strict and their mothers as nurturing. However, they expressed a desire for more openness and a safe emotional space within their relationships with their parents. While young adults acknowledged positive aspects of their upbringing, they also highlighted areas where they felt restricted or unsupported, particularly in expressing vulnerability and exploring personal identity.

Exploring human defence responses in a 3D virtual reality environment: An EEG study

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Introduction

Fear plays an integral role in an organism's lifespan to defend it from threats, making it an essential part of the survival mechanism. The defensive behaviours not only avert predators but also increase the prey's chances of survival. Fanselow and Lester (1988) created a predatory imminence continuum that displays the psychological perception of the threat's imminence to visualise the risk level for the prey. One end of the continuum denotes complete safety, and the other depicts the chances of being consumed by a predator. The current study investigates the fight/flight responses in humans and underlying neural correlates using EEG in a virtual reality (VR) environment.

Methods

The experiment (N=16, Mean age(SD)=23.94(3.45)) consisted of a desktop VR environment with an urban street view. The task of the participant involved locating a box item presented pseudo-randomly in one of the 4 streets. The experiment consisted of a training (familiarisation with the task and controls) and an experimental phase (5 conditions). Conditions 1 to 4 included a threat avatar, whereas condition 5 did not. The conditions differed based on threat proximity (distal/proximal) and the participant's escapability (escape/no-escape). A total of 20 trials were presented, with each condition presented 4 times. Participants responded with a Fight/Flight response to the threat, followed by a rest scene of 10s and a fixation of 5s.

Results

A chi-square test indicated no significant difference between fight/flight responses across 4 conditions. A paired sample t-test indicated significant difference between Fight (M=2.94, SD=1.39) and Flight (M=1.00, SD=1.37), $t(15)=2.82$, $p=0.01$ of 'Proximal threat no-escape' condition only. A rmANOVA for reaction-time indicated significant difference across 4 conditions, $F(3,45)=3.26$, $p=0.03$, $\eta 2=0.18$. Time-frequency analysis of 8-channel EEG data (N=9) over frontal regions showed peaks in delta-power across conditions; however, an overall low power was assessed for all the frequency bands.

Discussion

A heightened fight response was observed across all conditions, as in the VR environment the participants' actions did not involve consequences compared to real-life scenarios. A significant difference in reaction-time indicates distinction based on threat proximity and escapability. The delta-power observed across conditions may indicate not only an involvement of emotional (threat) and cognitive (fight/flight) components but also an underlying neural distinction for threat and no threat conditions.

Effect of inhibitory control training on extinction of conditioned fear

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Introduction

A substantial number of individuals fail to achieve clinically significant symptom relief from exposure-based therapies This may be due to the deficits in extinction learning (Craske et al., 2008) and more specifically, deficits in inhibitory learning during extinction (Milad et al., 2013). As such, there is tremendous potential in optimizing inhibitory learning during extinction to compensate for such deficits. Inhibitory control is also known as response inhibition. It is concerned with deliberately inhibiting a dominating and automatic response.

Inhibition here does not mean inhibition as in activation models which are automatic processes.

Inhibition as an executive function is a conscious inhibition of proponent responses (Logan, 2014). Inhibition is studied in laboratory through various tasks that are mostly timed for e.g., Flanker task, Stroop task, stop-signal task etc.

Cognitive control also referred to as executive functions (Diamond, 2013) involves a set of higher order cognitive functions that are involved in conscious control of attention, thinking, emotions and actions. According to Miyake's model (2000) executive functions involve three distinguishable functions: (i) Shifting, (ii) Updating and (iii) Inhibition.

Previous research suggests low executive function capacity might delay extinction, because individuals are slower to form novel inhibitory associations blocking the expression of excitatory associations (Niederstrasser et al., 2016). Such excitatory associations prompt automatic fear responses, which are difficult to withhold intentionally (Miyake et al., 2000). Difficulty to inhibit fear responses might hamper extinction learning.

Methods

We used a 3 day Screaming Lady fear conditioning paradigm with 33 participants (Males=16, Females=17). Habituation and Acquisition occurred on day 1 with 4 and 16 trials of each CS respectively. Extinction occurred on day 2 with 12 trials of each CS. Re-extinction took place on day 3 with 6 trials of each CS. The trials in each phase were presented pseudorandomly and the CS+ stimuli was counterbalanced across participants. Each CS was presented for 8 seconds, and CS+ was followed by a UCS (fearful expression face and scream) for 3 seconds on 75% of the trials during acquisition. Each CS was followed by an ITI of 10 to 12 seconds.

The experiment consisted of two groups: Inhibitory control training and extinction group (ICSE) (N=15) and Standard extinction group (SE) (N=18). All the groups followed the same procedure except for day 2, in IC-SE group on day 2 participants were trained on stop-signal task followed by extinction.

Stop-signal task:

The stop-signal task consisted of a total 240 trials with 180 go-trials and 60 stop -trial. Participants were first presented with a practice block consisting of 24 trials with 6 stopsignal trials. The training took place in 6 blocks, each block consisted of 40 trials with 10 stop trials in each block. In Go-trials, participants were requested to respond as quickly and accurately as possible to the direction of the arrow appearing on the screen for 1500 ms. Each arrow was followed by a fixation cross of 500 ms. The participants were instructed to respond with 'p' when the direction of the arrow was towards right and to respond with 'q' if the direction of

the arrow was towards left using the keyboard. During stop-trials, participants would hear a beep meaning that they have to inhibit their response. In the beginning of the task, the beep was emitted at 250 ms following the display of the arrow. This delay increased by 50 ms when the response was successfully inhibited and decreased by 50 ms when the response was not inhibited. The outcome variable for this task was the stop signal reaction time (SSRT). The latter was computed by subtracting the mean reaction time on go trials from the averaged stop signal delay.

Results

An independent sample t-test on CS+ expectancy rating during extinction t (31) = -2.375, p = .025 and extinction recall t (31) = -2.401, p = .023 revealed a significant group difference. Further, we also found a significant group difference in subjective arousal of CS+ during extinction t (31) = -2.239, p = .032 and re-extinction t (31) = -2.347, p = .025. The IC-SE group showed reduced UCS-expectancy and subjective arousal during extinction and reextinction than SE group.

Discussion

Our results suggests that training on inhibitory control task enhances inhibitory learning resulting in reduced expectancy of UCS during extinction and re-extinction. It seems that inhibitory control training aids formation of novel inhibitory associations (CS+ not followed by UCS) blocking the expression of fear expectancy (CS+ followed by UCS) during extinction and re-extinction (Rao et al., 1987). Further, since the UCS expectancy in IC-SE group is less, it implies that since the anticipation to encounter the UCS is low, it is possible that the subjective arousal associated with CS+ is also low. Therefore, it seems that inhibitory control and extinction might involve similar mechanisms. Further, brain imaging techniques will aid in exploring the common underlying neural structures.

Visual perception during neurotypical development and in Autism and ADHD

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Introduction

Visual perception continues to mature and evolve throughout childhood and might have a deviant trajectory in developmental disorders like Autism and Attention Deficit Hyperactivity Disorder (ADHD). Previous studies have studied specific perceptual phenomena with age and across autism and ADHD (e.g., Benassi et al., 2021, Ayzenberg & Behrmann, 2024, Luo et al., 2021 Guy et al., 2016). These paradigms often require specific task training and therefore it becomes difficult to assess the same child across multiple perceptual phenomena which would give a broader characterization of perception with age and across disorders. Here, we aimed to address this gap by developing a single paradigm to test a broad range of perceptual phenomena in neurotypical children as well as children with autism and ADHD).

Methods

We designed a series of visual search experiments in a game-like format, where the child or adult participant had to locate the oddball target among distractors using a keypress. The gamelike format was introduced to enhance the child-friendly nature of the experiments. Reaction time (RT) and accuracy were used as measures of visual search efficacy. The study employed a cross-sectional design spanning age groups corresponding to early (4-7 years) and late childhood (9-12 years) (samples sizes ranging from N=30 to N=40 for each group), adults (N=20) and children with Autism/ADHD (samples sizes ranging from N=18 to N=32)

Results and Discussion

We tested adults, neurotypical children (lower & upper age group), and children with Autism or ADHD for their ability to experience a variety of classic perceptual phenomena, ranging from coarse object structure to object invariance. The results for each test are summarized below.

Perceptual space. We found similar perceptual space distributions for stimuli (comprising animals and objects) across the age and diagnostic groups (Autism/ADHD).

Mirror confusion. Strong mirror confusion effects were seen across all groups across age and diagnoses with vertical mirror flips being difficult to search when compared to horizontal mirror flips. The strength of the mirror confusion effect was seen to weaken from early childhood into adulthood in the neurotypical group. Mirror confusion effects were observed to be stronger and weaker in ADHD and Autistic participants respectively when compared to their neurotypical counterparts.

Global-local processing. Mixed findings were observed in the case of global-local processing. Global-local processing was quantified as the normalized RT difference between visual searches comprising only global or only local changes in hierarchical stimuli. The local advantage in visual search was seen to drop from early into late childhood with a sudden unexpected increase in adulthood. At a trend level neurotypical children also showed a greater local processing advantage when compared to both the ADHD and Autistic groups.

Face perception. This was measured across two experiments comprising a) human and animal cartoon faces and b) real human and animal aligned vs misaligned faces *(run only for neurotypical participants)*. In the case of cartoon faces, we measured sensitivity to feature vs configuration changes and face inversion effects. This was quantified as the normalized RT difference between visual searches comprising feature vs configuration changes and upright vs inverted faces, respectively. Trends showed progressively greater sensitivity to feature changes from early childhood to adulthood for both human and animal upright and inverted faces in neurotypical participants. Children with ADHD found configuration changes easier to detect in human faces and feature changes easier to detect in animal faces. Children with Autism on the contrary showed a consistent advantage for feature change detection across both human and animal faces. In the neurotypical group, face inversion effects were seen to increase from early childhood into late childhood for human faces with a sharp drop in adults. In the case of animal faces face inversion effects saw a progressively declining trend from early through late childhood to adults. Children with ADHD showed greater face inversion effects in the case of human cartoon faces but significantly lesser face inversion effects in the case of animal cartoon faces. Children with Autism showed lesser face inversion effects for both humans and animals when compared to neurotypical controls.

In aligned vs misaligned human and animal faces, the holistic processing of faces was quantified as the normalized RT difference between visual searches comprising aligned faces and misaligned faces. A progressive increase in holistic processing was seen from early childhood into adulthood for human faces with an exactly opposite trend for animal faces. *Object invariance.* We also measured perceptual invariance in the neurotypical group across three domains-size, view, and rotation. Preliminary results obtained indicate that view invariance is the weakest in early childhood whereas rotation invariance is the strongest. A similar pattern of development is seen for both size and rotation invariance with adult-like patterns seen in late childhood. View invariance exhibits a more gradient development with the highest point reached in adulthood.

Conclusion

Taken together, our results reveal differing patterns of development across age and developmental atypicalities for varied visual perceptual phenomena. These unique patterns can act as the groundwork for correlating visual and other sensory development particularly in atypical populations and in the long term aid the development of visual training paradigms for effective rehabilitation.

Evaluating smartphone notifications as an ecologically valid conditioned stimulus for studying emotion-evoked neural responses

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Introduction

With increasing use and dependence on smartphones, smartphone notifications can have strong emotional associations for certain users [1]. In different contexts, the notifications may evoke positive or negative emotions. For instance, a notification from a loved one might trigger feelings of joy, while a work-related alert could induce stress or anxiety. The monitoring of smartphone notifications, combined with self-reported emotional state assessments, reveals a strong correlation between a user's emotions and the type of notification received [2].

Conventionally evoked neural responses to emotional stimuli have been studied in relatively artificial contexts – subjects are conditioned to associate benign stimuli with stressors, and then the impact of the conditioned stimulus is assessed. Smartphones provide a naturally conditioned stimulus, thus eliminating the need for artificial conditioning, and making the experiments more ecologically valid.

To understand the neural impact of conditioned smartphone notifications, we follow a paradigm similar to Schirmer and Escoffier, 2010 [3]. In the 2010 study, participants watch a silent movie while task-irrelevant auditory stimuli are provided in the background, consisting of syllables uttered in neutral and angry tones. The study revealed differential recruitment of the autonomic response system for the two tones (Fig. 1).

Following the same paradigm, we replace the angry and neutral syllables with a notification sound and a monotone beep. For 50% of the participants, the notification is personalized so that they self-report specific emotional responses to it. For the remaining participants, a control notification sound is played that they do not have strong associations for. This design allows us to study the impact of specific emotion-evoking notification sounds compared to unfamiliar notifications against the baseline responses to a non-notification beep sound.

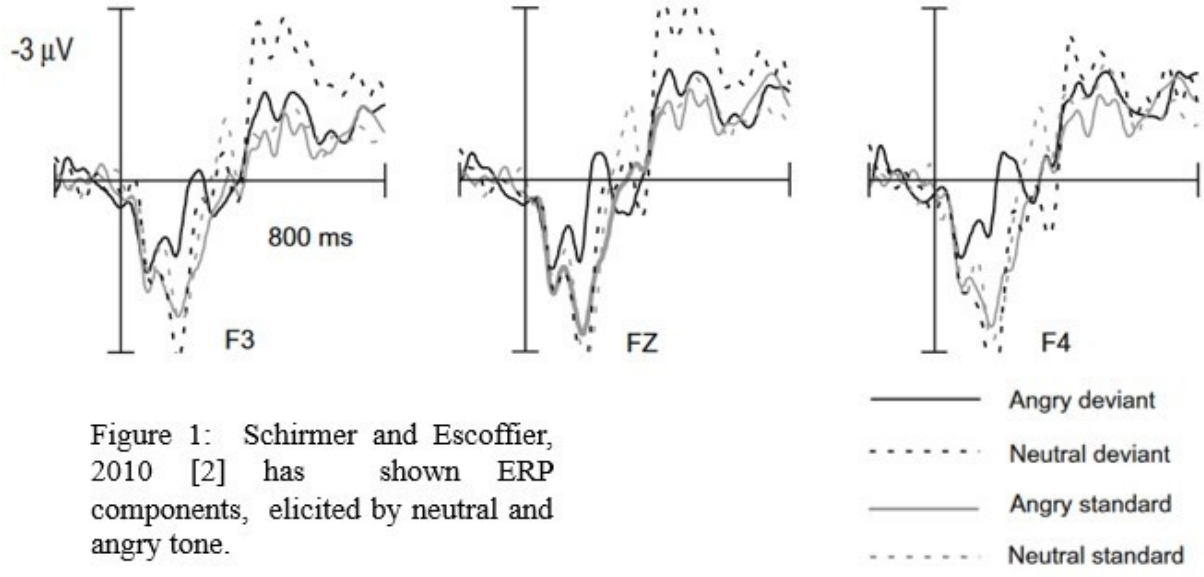

Figure 1: Schirmer and Escoffier, 2010 [2] has shown ERP components, elicited by neutral and angry tone.

Methods

Based on the task-irrelevant auditory oddball paradigm, our experiment comprises two blocks, in one of which the personalized notification functions as the deviant tone, whereas in the other, it serves as a standard tone. Each block consists of 900 trials with 1/6th of the trials comprising of the deviant tone. The number of standard tones between two consecutive deviant tones varies between three and nine. The duration of each trail is 1300 ms, and each auditory stimulus starts between 300 ms and 310 ms randomly within a trial. The length of each audio stimulus fluctuates between 700 ms and 710 ms. The participant watches a silent movie while sitting in a comfortable chair and receives notifications from the headphone (Fig. 2). Given that it is an irrelevant auditory oddball task, we instruct them to disregard the notification and focus on the movie.

To assess participants' attentiveness during the task, we pose a set of five questions related to the video after each block. During the task, we collect Electroencephalogram (EEG) data using the standard 64-channel actiCHamp system at 1000 Hz sampling rate. Following EEG data collection during task, participants' responses are being gathered using the standard smartphone addiction scales, Smartphone Addiction Scale (SAS) -10 [4] and Mobile Phone Problematic Use Scale (MPPUS)-10 [5].

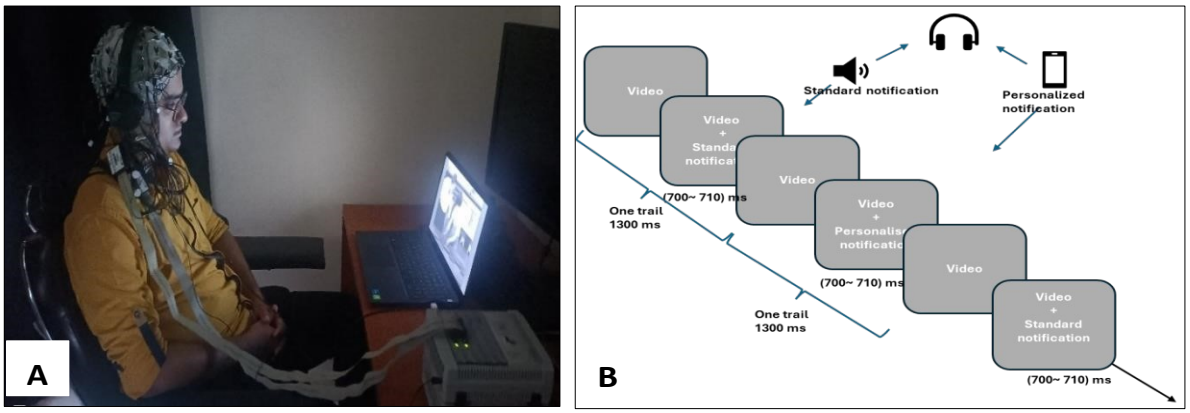

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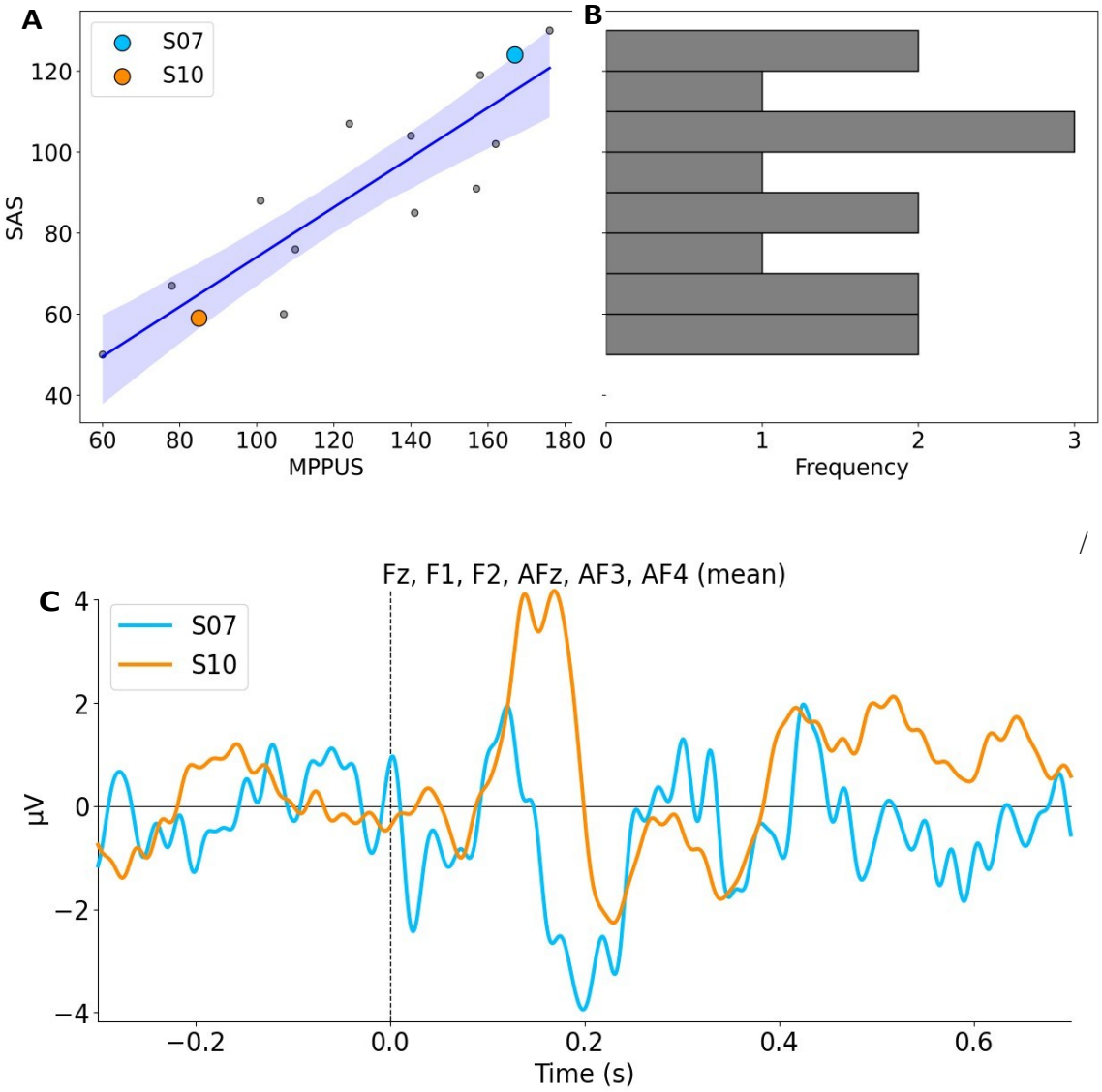
Figure 2: A) EEG data collection while participant performing task; B) Experiment protocol for the irrelevant auditory odd ball task with the personalised notification as a deviant tone in first block.

Results

In this study, we analyzed data from 14 subjects with an average age of 27 years. The MPPUS scores ranged from 60 to 167, with a mean of 126.14 and a standard deviation of 35.32. The SAS scores varied from 50 to 130, with a mean of 90.14 and a standard deviation of 24.55. A strong correlation of 0.88 was observed between MPPUS and SAS scores. (Fig. 3a). This suggests that participants are providing reliable responses consistent across different assessments.

We conducted a preliminary Event-Related Potential (ERP) analysis comparing two subjects, S7, with low SAS score (59) and S10 with a high SAS score (124) with the mean signal at channels Fz, F1, F2, AFz, AF3 and AF4. The Mismatch Negativity (MMN) ERP component was obtained by subtracting the ERP response of the standard beep tone from that of the deviant personalized tone in first block. Like the ERP responses elicited by neutral and angry tones, personalized notification and beep tones also evoke MMN ERP components in the frontal region. Similarly for the second block, MMN ERP component

was obtained having personalized tone as standard tone. The final ERP component was obtained by subtracting the MMN ERP component of the first block from that of the second block (Fig. 3b). This helped to evaluate the actual effect due to personalized tone controlling for the effect purely due to deviation. The negative amplitude of the ERP component was greater in the subject with higher smartphone usage metrices compared to the subject with lower metrices.



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/ Figure 3: (A) Scatter plot between MPPUS score and SAS score with a linear trendline with the histogram of SAS scores (B) for all participants. (C) Personalised notification evoked ERP component of subject S7 and S10 with average at frontal channels Fz, F1, F2, AFz, AF3 and AF4.

Facial Emotion processing in Early Alzheimer's Disease, Mild Cognitive Impairment & Healthy Individuals

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Introduction

Alzheimer's disease (AD) is the most common form of dementia which disrupts a person's memory, language, emotion, and the ability to think. It is an age-related neurological pathology, which predominantly induces severe dysfunctions to memory, especially in the formation of new memories. Everyday memory gradually gets deteriorated on the course of healthy aging. Moreover, emotion processing and memory abilities deteriorate considerably in mild cognitive impairment (MCI) and AD. Facial emotion processing is the essential component of nonverbal communication. In normal ageing as well as in age related pathologies, facial emotion processing gets affected. There is lack of studies pertaining to assessment of emotion processing in dementia and hence there are no standardised emotion-based paradigms for its assessment. Studies are essential for establishment of emotion-based memory assessment paradigms for dementia screening, and it need to be standardized to use in Indian population, emphasising Indian languages. Novel neuropsychological-diagnostic markers need to be established for classifying AD, MCI and healthy controls.

Objective

The aim of this study is to validate facial emotion processing paradigms and study its efficacy in classifying patients with MCI or early AD, compared with normal elderly individuals.

Methods

The methodology used in the study was adopted from previous study by Gupta & Srinivasan, 2009, and was customised to administer in elderly individuals and patients, in vernacular language of Malayalam. The experiment involves two phases - an encoding phase followed by a recognition phase. In each encoding trial, the face stimulus (happy, sad, or neutral) was randomly presented with its name underneath it. The participants were asked to learn these face name associations presented in vernacular language Malayalam. The interval between successive face presentations was 3 seconds. Immediately after the encoding phase, a twochoice recognition test was administered with the whole-face and parts of face (eyes, mouth).

In whole face trial condition, participants were presented with two faces, the target and foil. The target and the foil faces did not differ with respect to emotional expressions. In the isolatedpart condition, participants were presented with one feature from the target face and foil feature displaying the same emotion. Participants were instructed to find the target face (whole-face condition) or the target feature (isolated-part condition). Figure (a) depicts the study phases with example of stimuli used.

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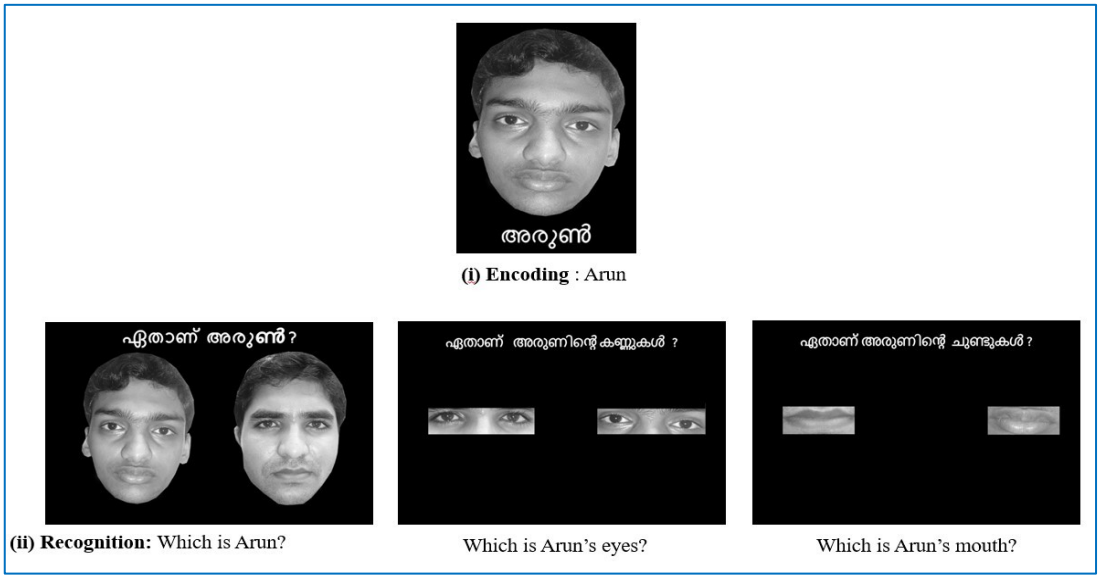
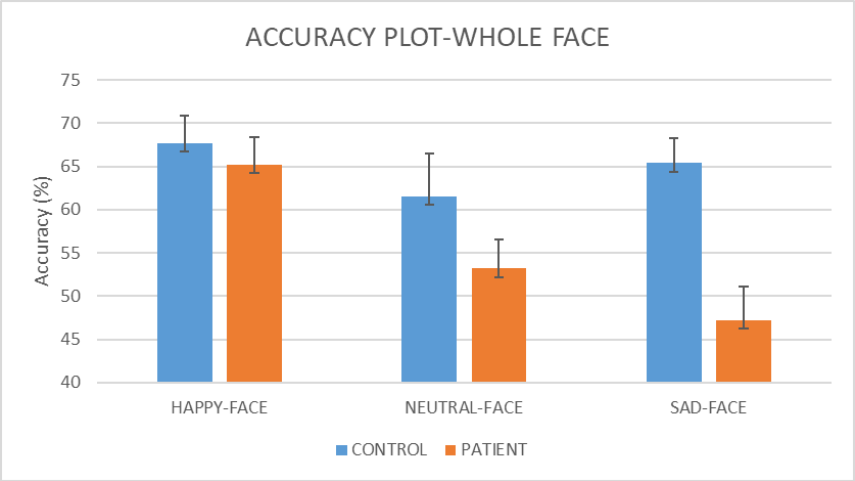


Figure (a): Image details the study phases and the example of stimuli used

Result

The sample size of the study was 38, which included 25 patients (female 12, male 13) and 13 elderly controls (female 5, male 8) of age above 55 years. We computed the recognition accuracy for faces and parts of face (eyes, mouth) corresponding to emotional expression (happy, neutral and sad) and plotted the result for controls as well as patients. Statistical analysis was performed using T-test for within and across group comparisons with emotions (happy, sad, neutral) for face-type (whole, eyes, mouth) on recognition accuracy score.

In healthy control group, recognition accuracy of whole faces for all emotions were similar (happy vs. sad, t (12) = 0.42, p = 0.63; happy vs. neutral, t (12) = 1.19, p = 0.23; sad vs. neutral, t (12) = -0.64, p = 0.52). Interestingly, individuals with AD were better in recognizing whole faces with happy expressions compared to sad, t (24) = 3.02, p = 0.005; and neutral expressions, t (24) = 2.63, p = .01. There was no significant difference in recognizing whole face with sad and neutral expressions, t (24) = -1.11, p = 0.27. These results indicate that recognition of happy facial expressions, compared to sad facial expressions, are quite intact in individuals with AD (see Figure b).



/Figure b: Accuracy plot for whole face (Control Vs Patient)

Whole face result on Controls described, Happy (67.7%) and sad (65.4%) faces were remembered better compared to non-emotional faces (61.5 %). For Patients, Happy (65.2%), sad (47.2%) and non-emotional faces (53.2%) were remembered.

Corresponding to face parts, the recognition accuracy for happy eyes, compared to neutral eyes, was better in healthy controls. Rest of the pair-wise condition was not significant ($p > 0.07$, for all). In patient group, recognition accuracy for eyes condition for all expressions were similar

($p > 0.14$, for all). Recognition accuracy for eyes, corresponding to emotional expression (happy, neutral and sad) illustrates, for Controls, Happy (58.5%) and sad (44.6%) faces were remembered better compared to non-emotional faces (45.4%). For Patients, Happy (55.2%), sad (49.2%) and non-emotional faces (49.6%) were remembered.

Recognition accuracy for mouth condition was similar for all expressions in both groups (for healthy controls: $p >0.18$, for all; for patient group: $p >0.74$, for all).

These results may indicate that part-based processing is helping only for happy emotions in healthy controls; but happy face expressions are helping to patient group with whole-face processing only.

Recognition accuracy for mouth, agreeing to emotional expression (happy, neutral and sad) illustrates For Controls, Happy (53.1%) and sad (50%) faces were remembered better compared to non-emotional faces (45.4%). For Patients, Happy (50%), sad (50.4%) and nonemotional faces (49.6%) were remembered. (Figure c).

Conclusion

Interestingly, individuals with AD were better in recognizing whole faces with happy expressions compared to sad. These results indicate that recognition of happy facial expressions, compared to sad facial expressions, are quite intact in individuals with AD. These results may indicate that part-based processing is helping only for happy emotions in healthy controls; but happy face expressions are helping to patient group with whole-face processing only. This could be used as a marker in classifying pathological population and it also provides insights towards designing emotion based cognitive retraining strategies.

Ethical Statement: The study was approved by Ethics committee of Sree Chitra Tirunal Institute for Medical Sciences & Technology Trivandrum.

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Replication and Validation of Trait Anxiety EEG Biomarkers Utilizing Stop-Signal Task

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Introduction

Trait anxiety (TA) refers to a consistent and enduring predisposition to react with worry, unease, or fear when faced with stressors or perceived threats[1]. It is characterized by a stable pattern of anxious feelings and reactions that persist over time and are not limited to specific events or circumstances.

Electroencephalography (EEG) has proven to be an invaluable method for exploring the neural underpinnings of cognitive processes, thanks to its high temporal resolution and capacity to capture real-time brain activity. Building on this capability, research has investigated how TA affects various cognitive functions. Specifically, studies have focused on understanding the influence of TA on cognitive processes such as inhibitory control and error monitoring. For example, Hsieh et al. (2021)[2] used event-related potentials (ERPs), including error-related negativity (ERN) and error positivity (Pe), in conjunction with the stop-signal task (SST) to examine how TA impacts these processes. Similarly, Savotyanov et al. (2008)[3] explored the relationship between TA and eventrelated EEG oscillatory responses within the SST paradigm. These studies highlight how different EEG analysis techniques can provide insights into the neural activity associated with TA.

Motivation & Aim

Since these two researches utilize the same paradigm (SST) and neuroimaging technique (EEG), the motivation behind this research is to establish a reliable EEG biomarker for TA by validating this biomarker through application of Alexander's oscillatory analysis, Event Related Spectral Perturbation (ERSP) to Hsieh's dataset and using Hsieh's ERP analysis on Alexander's data, also replicating the same method on its own dataset. This cross-application and internal validation will evaluate the reliability and accuracy of the TA biomarkers, enhancing their precision and practical
utility.

Method

Data & Analysis

Hsieh et.al., 2021: Participants completed the State-Trait Anxiety Inventory-Trait (STAI-T), and based on their STAI-T (TA) scores, they were classified into high trait anxiety (HTA) and low trait anxiety (LTA) groups.

EEG data were recorded from all participants while they performed the SST using a 34-channel EasyCap with Ag/AgCl electrodes, following the 10–20 system. Data acquisition was conducted with a 40-channel QuickAmp system at a sampling rate of 1,000 Hz.

The ERP components of interest were derived by subtracting the responses to Correct Go (CG) trials from those of Unsuccessful Stop (US) trials, resulting in the ΔERN and ΔPe components at the FCz electrode and Pz electrode respectively.

Savotyanov et.al., 2008: Since the data from the original study was unavailable, we utilized a new dataset[4] provided by the same author, in which participants performed the same paradigm (SST) along with additional tasks. The analysis method from the original study was applied to this new dataset.

In this dataset, participants completed the STAI-T and were categorized by their scores. EEG was recorded during the SST using a 128-channel system with electrodes positioned

according to the 5–10 system. The Cz channel served as the reference and AFpz as the ground, with impedance kept below 5 kΩ. Signals were amplified with a Brain Products actiChamp system, filtered at 0.1– 100 Hz, and sampled at 1,000 Hz.
The ERSP-indices with topographical distribution of spectral power for time–frequency intervals with most significant reactions were computed for successful GO and successful STOP conditions for both high and low TA levels.

The common experimental paradigm: SST

The stop-signal task consists of “Go” trials and “Stop” trials. During "Go" trials, they are shown a Go-signal and must quickly press a corresponding button as quickly and correctly as possible; responses must be timely to avoid penalties for delays or mistakes. In "Stop" trials, a Stop-signal appears after the Go-signal, prompting participants to inhibit their response.

Results
By subtracting responses to CG (Correct Go) from those to US (Unsuccessful Stop), our preliminary analysis (fig.2 & fig.4) confirms the presence of ΔERN and ΔPe, consistent with the original research[3]. However, we observe a significant difference in the magnitude of the effect compared to the reported results (fig.1 & fig.3).

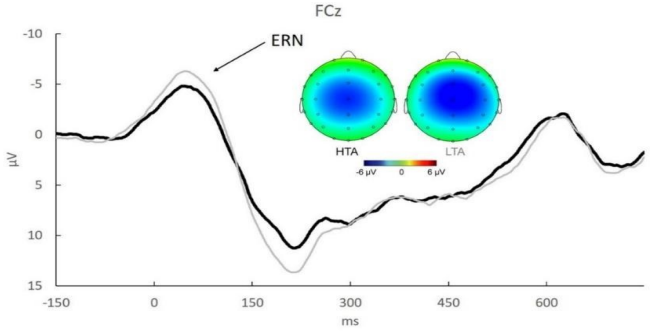

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Fig.1: Reported results in Hsieh et.al., 2021: Response-locked grand average ΔERN at FCz.

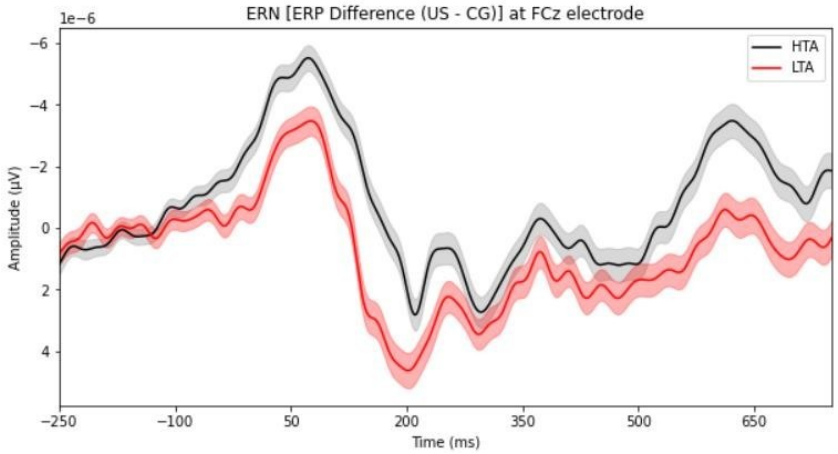

Fig.2: Replicated results: Response-locked grand average ΔERN at FCz.

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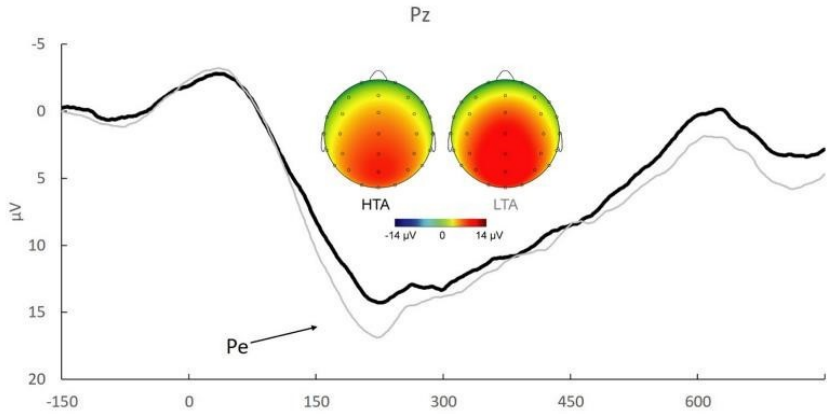

Fig.3: Reported results in Hsieh et.al., 2021: Response-locked grand average ΔPe at Pz.

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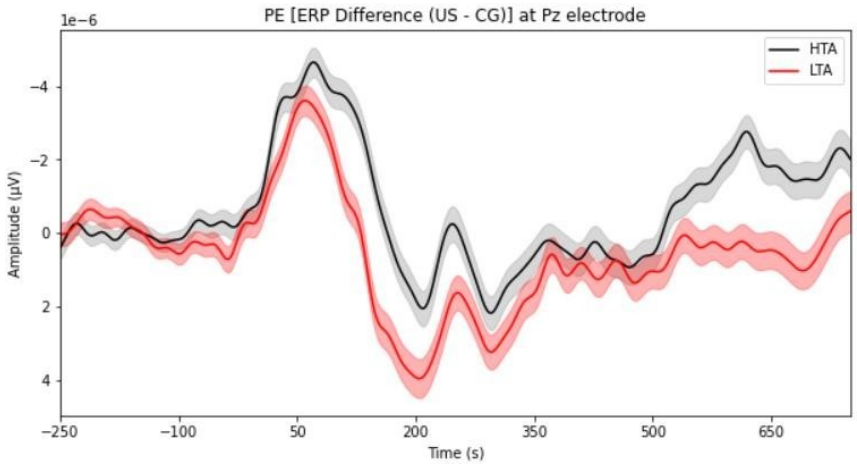

Fig.4: Replicated results: Response-locked grand average ΔPe at Pz.

Discussion

The preliminary cross-analysis on one of the two studies reveals a discrepancy in ΔERN and ΔPe magnitude compared to the original study. We are currently evaluating the cause for this discrepancy. The second study is ongoing for further validation.

Our analysis is already highlighting the need for replication and cross-validation studies for establishing better science, and better science communication. For instance, we find that the methods provided in one of the articles are not sufficient to replicate the analysis results presented therein.

More broadly, accurate objective assessment of anxiety can enhance the precision of evaluations, leading to more effective and personalized interventions. By replicating two different proposed biomarkers for TA across datasets, our study aims to establish a more reliable biomarker for TA.

Free-choice intentions but not instruction-based action planning influences subsequent executive control

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IIT Kanpur

Introduction

Intentions can bias attentional processing not only during action execution but also after its completion, possibly due to outcome monitoring (Pacherie, 2006). Earlier findings utilizing a modified flanker task (Sharma, Kumar, & Srinivasan, 2024) indicate that intentions influence performance on the flanker task by increasing the activation of intentionally selected features and suppressing the unselected features. However, it is not clear whether these effects are due to instruction-based action planning or the intention to get a desired outcome since priming of feature, along which intention is made, can lead to facilitation of responses in the subsequent task. In the current study, we attempt to replicate the earlier findings (in Experiment1) using the free-choice task embedded in an Eriksen flanker task (Eriksen & Eriksen, 1974) with letters. To dissociate the intention versus instruction-based effects, we used the same flanker task preceded by a simple instruction-based action instead (Experiment2). We hypothesized an interaction between flanker and outcome congruency in Experiment 1 (intention-based) but not in Experiment 2 (instruction-based).

Methods

Participants

To obtain an effect size of n_p^2=0.15 (Sharma et. al., 2024) for two-way interaction in a repeated measures ANOVA for alpha=.05 and power=.8, the predicted sample size was 30 (calculated using MorePower v6.0, Campbell & Thompson, 2012). We conducted the experiments on 16 participants
(aged 22-32 years, 5 females) for Experiment 1 and 30 participants (21-33 years,12 females) for Experiment 2. The data collection for experiment 1 is still underway.

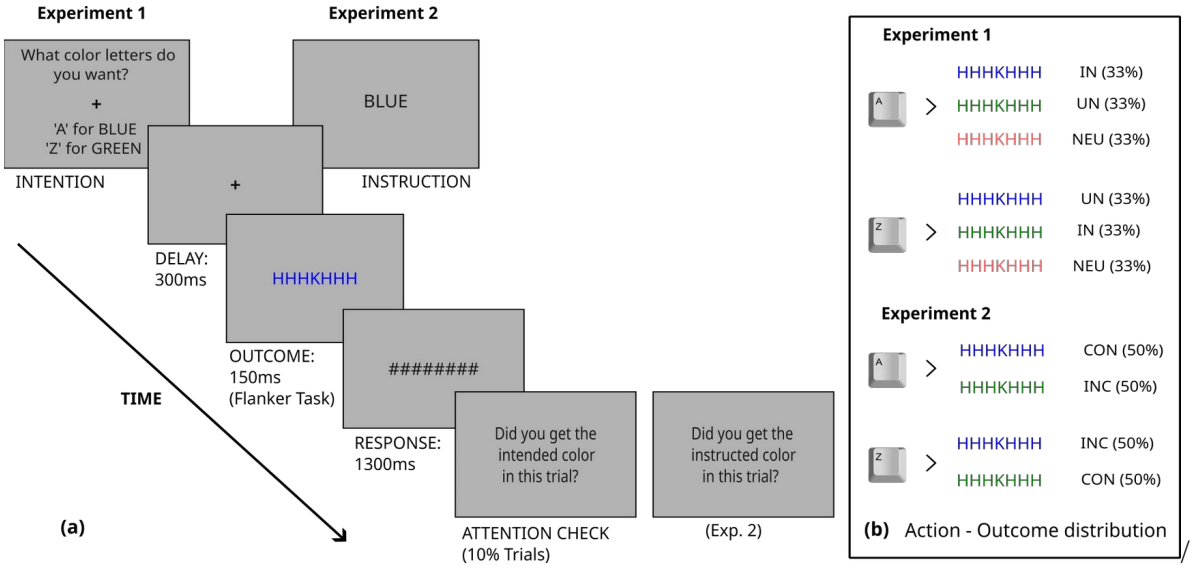

Figure 1. (a) Trial structure. (b) Distribution of outcomes for 'A' and 'Z' keypress. IN=intended, UN=unintended, NEU=neutral, CON=congruent, INC=incongruent.

Stimuli and Apparatus

For experiment 1, the stimuli consisted of a target letter (H or K, size 0.8ºx0.4º) with congruent (HHHHHHH) or incongruent (HHHKHHH) flankers presented in one of three colours (blue, green, and pink) against a gray background. Similar stimuli were used in experiment 2 with the difference that the stimuli were presented in one of two colours (blue or green). While the target was presented at the fixation, the flankers were presented at an eccentricity of ±0.5º, ±1.0º, and ±1.5º on either side of the target. Participants sat 80cm from the monitor and responded using a standard keyboard. The experiment was created using PsychoPy 2023.1.3 (Peirce et al., 2019).

Design and Procedure

Design was similar to Sharma et al. (2024). To increase task difficulty, we used backward masked letter stimuli presented for 150ms. In experiment 1, at the beginning of each trial participants intended the colour in which they want to see the subsequent letters (selected using 'A' or 'Z' keys). This was followed by backward masked flanker stimuli presented in either intended, unintended, or a neutral colour (Figure 1). Participants indicated the target letter using arrow keys (left arrow for H and right arrow for K). Each participant completed 408 trials in the main session (consisting of 2 flanker conditions [congruent, incongruent] x 2 intention outcome conditions [intended, unintended, neutral] x 68 replications) in addition to a 20-trial practice session. All conditions were presented an equal number of times. Additionally, we included catch trials (10%) where, after the flanker task, the participant was asked whether the colour of the target matched their intention or not.

In Experiment 2, the intentional choice was replaced by a single colour name (Blue or Green) and participants had to press the associated key ('A' or 'Z'). Here, each participant completed 272 trials (consisting of 2 flanker conditions [congruent, incongruent] x 2 prime outcome conditions [same, different] x 68 replications) after a 20-trial practice round. 10% of the trials were catch trials for attention check similar to Experiment1.

Results

Data cleaning

Data from participants with lower than 60% catch trials accuracy were removed from further analysis and replaced. Reaction times (RTs) and accuracy in flanker task were analysed after outlier removal. For each participant, trials beyond mean RT±3SD and trials with less than 100ms RT were removed from further analysis (~1% trials in each experiment).

Experiment 1

Accuracy: A 2x3 repeated measures ANOVA for mean accuracy data showed a significant main effect of flanker congruency, $F(1, 15)=17.683$, $p<.001$, $n_p^2=0.541$, with higher accuracy for congruent (.95) than incongruent (.90) flankers. The main effect of outcome congruency, $F(2, 30) = 0.007$, $p = .981$, $n_p^2 = 0$, and the interaction, $F(2, 30) = 1.116$, $p = .329$, $n_p^2 = 0.069$, were not significant.

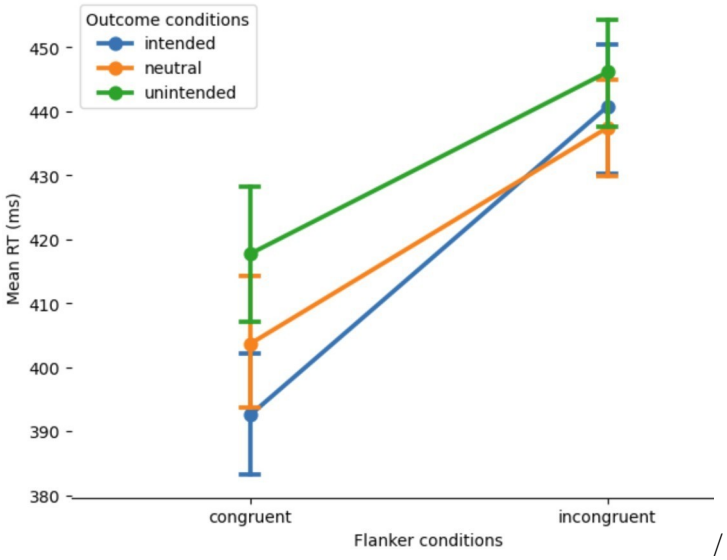

Figure 2. Mean correct RTs for Experiment 1. Error bars represent within-subject confidence interval.

Reaction Time: A 2x3 repeated measures ANOVA for mean correct RTs showed a significant main effect of both flanker congruency, $F(1, 15) = 33.674$, $p < .001$, $n_p^2 = 0.691$, with faster RTs for congruent (420ms) than incongruent (458ms) flankers; and intention congruency, $F(2, 30) = 5.435$, $p = .01$, $n_p^2 = 0.266$. Post hoc analysis indicates that responses for intended outcome (433ms) were faster than unintended outcome (447ms), $t(15)=3.078$, $p <.022$, $d=0.115$, $BF_{10}=6.8$. Other differences were not significant (Figure 2). The interaction effect was not significant, $F(2,30) = 2.250$, $p = .133$, $n_p^2 = 0.130$. These results are in accordance with our hypothesis and are supported by previous findings (Sharma et al., 2024).

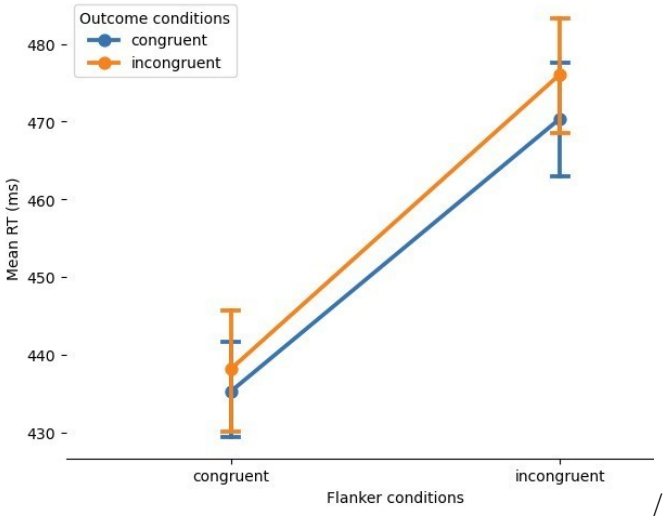

Figure 3. Mean correct RTs for Experiment 2. Error bars represent within-subject confidence interval.

Experiment 2

Accuracy: A 2x3 repeated measures ANOVA for mean accuracy data showed a significant main effect of flanker congruency, $F(1, 29)=4.512$, $p=.040$, $n_p^2=0.140$, with higher accuracy for congruent (.93) than incongruent (.89) flankers. The main effect of outcome congruency, $F(1, 29) = 0.087$, $p = .770$, $n_p^2 = 0.003$, and the interaction, $F(1, 29) = 0.008$, $p = .929$, $n_p^2 = 0.0003$, were not significant.

Reaction Time: A 2x2 repeated measures ANOVA for mean correct RTs indicates a significant main effect of flanker congruency, $F(1, 29) = 44.571$, $p < .001$, $n_p^2=0.614$, with faster responses for congruent (437ms) than incongruent (474ms) flankers. The main effect of outcome congruency, $F(1, 29)=1.110$, $p=.280$, $n_p^2=0.041$, and the interaction term, $F(1, 29)=0.195$, $p=.661$, $n_p^2=0.006$, were not significant. (Figure 3). These results support our hypothesis.

Discussion

We replicated the finding that intention-based actions yield the action monitoring effects, possibly via attentional mechanism (Experiment 1) with data collected so far. Additionally, the lack of effect with instruction-based actions (Experiment 2) rule out the possibility that obtained effect is due tomere action planning and colour feature acting as a prime, which is the same across both the experiments. Together these results support theories of intention like the dynamic theory of intention (Pacherie, 2006) that propose additional functional role of intention other than action planning, that is, intentions might also serve to control and monitor the action effect or outcomes in an uncertain environment. We plan to do drift diffusion modelling to further understand the specific processes that are influenced by intentions and not instructions.

High Schizotypy is associated with greater susceptibility to tactile illusions and intact vibrotactile perception

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Introduction

Schizophrenia is a complex neuropsychiatric disorder characterized by delusion, hallucinations, disorganized thought, and cognitive impairments. Patients with schizophrenia have shown impairments in sensory perception in all modalities, including somatosensory and proprioceptive processing (Michael & Park, 2016). Similarly, studies have shown that individuals with high schizotypy, a spectrum of personality traits that are found in normal populations in varying intensity with the pathological state leading to schizophrenia, share these deficits. Individuals with high Schizotypy show somatosensory processing deficits like elevated thresholds in two-point discrimination tasks, Temporal-Order Judgment tasks, and graphesthesia tasks (Chang &
Lenzenweger, 2005; Ferri et al., 2016). In this study, we are interested in understanding the difference in the perception of cutaneous vibrotactile stimuli in subjects who differ in their schizotypy scores. We screened participants based on their scores on the Schizotypal Personality Questionnaire (SPQ-A) and tested their performance on 6 vibrotactile tasks delivered to their fingers.

Methods

A total of 48 participants (mean age = 21.6, male: female = 34:14) were classified into different schizotypy groups based on their scores on the Schizotypal Personality Questionnaire (SPQ-A) (Raine, 1991). Participants scored in the first, fifth, and tenth centiles were classified into high, mid, and low schizotypy groups respectively, with each group having 16 participants. All participants completed the following six vibrotactile tasks delivered on their index and middle fingers. The tasks included detection of the presence of vibrotactile stimuli (1. simple reaction time task), detection of highest amplitude (2. simultaneous amplitude discrimination task, 3. sequential amplitude discrimination task), detection of the longer stimuli (4. duration discrimination task), detection of first of the two stimuli (5. temporal order judgment (TOJ) task) and detection of highest amplitude when an illusory adaptation vibrotactile stimulus is given on one of the fingers before the simultaneous amplitude discrimination task (6. Single Site Adaptation (SSA) Task).

Results

The discrimination thresholds were different for the three groups (high, low, and mid schizotypy) only for one task, the single site adaptation task for amplitude discrimination (ANOVA F (2,45) = 6.036, p = 0.005**, η_p^2 = 0.212). The post hoc test for the SSA task showed a higher discrimination threshold for the high schizotypy group compared to the low (p=0.006**) as well as the mid (p=0.010*) schizotypy groups. Furthermore, we also observed that these discrimination thresholds showed a positive correlation with the corresponding individual SPQ scores (r = 0.438**, p = 0.002) and subscales [cognitive-perceptual scale (r = 0.441**, p= 0.002), interpersonal scale (r = 0.361*, p = 0.012), disorganized scale (r = 0.466***, p = <0.001)].

The other tasks did not show any significant difference between the groups in individual ANOVAs. Comparing the performance in simultaneous amplitude discrimination task with and without adaptation, only the task with the adaptation showed a significant difference between the groups [(F (2,45) = 0.717, p= 0.494, η_p^2 = 0.031) for the task without adaptation].

Discussion

In our study, the poor performance of individuals in the high schizotypy group in the SSA task could be due to the illusory effect induced by the adapting stimuli. The preceding vibrotactile stimulus had an overt influence on the subsequent stimulations because of deficiencies in temporal and spatial integration in the somatosensory system, thus leading to more errors in the task. Previous studies have shown that individuals with high schizotypy show higher susceptibility to visual illusions than controls, there are also reports that there is lower susceptibility to visual illusions (Notredame et al., 2014). Our study shows that in a vibrotactile illusion, high schizotypy individuals are more prone to tactile illusions than controls. This is confirmed by the observed positive correlation between SPQ scores and amplitude discrimination thresholds of the high schizotypy group. As the other tasks did not show any difference for individuals of varying schizotypy scores, we can conclude that the effect is specific to the tactile illusory task and not to basic perceptual processing.

This susceptibility to illusions can be explained by the circular inference model, which talks about the sensory processing impairments in individuals with schizophrenia. Whether the impairments affect the top-down apriori-based processing or the bottom-up stimulus-dependent processing determines if prior knowledge or sensory information dominates their final percept, respectively (Notredame et al., 2014). An over-weighting of prior knowledge due to high schizotypy traits could explain the observed proneness to tactile illusion. In conclusion, our study demonstrates the correlation between high schizotypy traits and increased susceptibility to tactile illusion task.

Exploring the relationship between Anxiety, Cognitive Function, and Heart Rate Variability in young adults

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Introduction

India is home to the largest number of adolescents and young adults in the world, comprising about a fifth of its population, who are increasingly showing mental health problems (Patel et al., 2012). Anxiety is one of the most common mental issues experienced by adolescents and young adults (Pal et al., 2022). Anxious individuals may have impaired performance on attention, inhibition, and working memory tasks (Berggren et al., 2013; Eysenck et al., 2010). Typically, anxiety is measured using anxiety questionnaires for subjective reporting, paired with physiological measures of anxiety such as skin conductance or heart rate. However, these physiological measurements are used to measure task-induced changes. In the recent decades, Heart Rate Variability (HRV) has become a common method to measure autonomic activity. HRV reflects the variation in the time interval (in milliseconds) between successive heartbeats (NN intervals) and is regulated by the parasympathetic and sympathetic nervous system. HRV indices like Standard Deviation of NN intervals (SDNN) seem to be a sensitive to changes in the mental state (Hilgarter et al., 2021). Our study explored the potential use of HRV in physiological measurement of anxiety as well as its relationship with cognitive performance. We focused on anxiety as a trait, a general predisposition of an individual at the time of participation. We did not induce anxiety.

We hypothesized that HRV and cognitive performance would be modulated with varying levels of trait anxiety. We used well established cognitive tests from different domains of cognition (working memory, attention, mnemonic discrimination) to understand the role of anxiety and HRV correlates before, after, and while performing the cognitive tests.

Methods

Young adults (N = 77) aged 20-31years (Mean = 23.9 years, SD = 2.11, Female=19, Male=58) participated in our study and gave detailed demographic information. Participants taking medication or therapy for depression or anxiety were excluded. Cognitive tests included n-back test for working memory, Simon's test for executive control, and mnemonic similarity task. Tests were administered in random order.

Subjective trait anxiety was measured using Spielberger's trait anxiety questionnaire.

HRV was recorded at baseline, during each cognitive task, and post cognitive testing. Recording for each instance lasted for 5 mins. We used Scosche Rhythm24 HRV monitor wrapped around the forearm and data was recorded using HR Monitor App on a smartphone.

Our data collection is ongoing, and these are preliminary results.

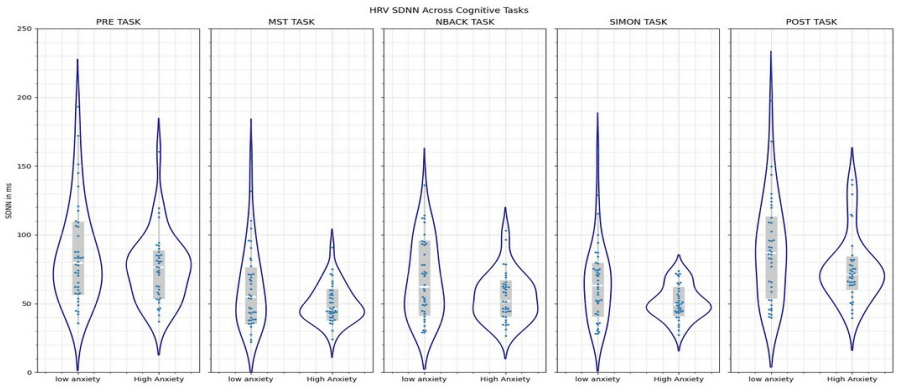
Results

SDNN was selected as measure of HRV, since variance in heart rate is mathematically equal to the total spectral power and reflects all the cyclic components responsible for variability in the period of recording. (Choi et al., 2020).

Using Pearsons correlations, we observed small but significant negative correlations of anxiety scores with HRV SDNN values, at baseline PRE_SDNN (r= -.26, p=0.02), and during the cognitive tests: Simon_SDNN (r= -.27, p=.016), NBACK_SDNN (r= -.31, p=.006), POST-TASK-REST_SDNN (r= -.25, p=.026). This indicated that HRV is sensitive to autonomic activity due to trait anxiety, regardless of rest or active periods.

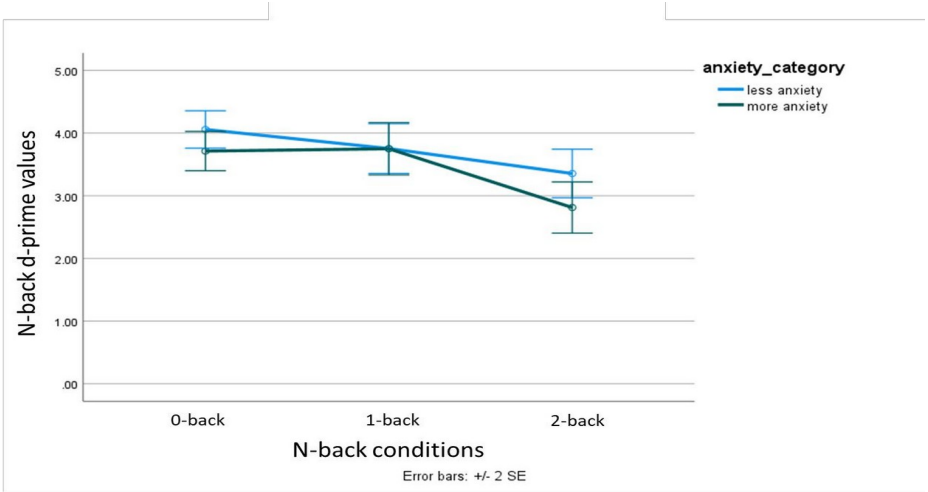
We divided participants into two groups based on their trait anxiety scores; high anxiety (>=44 and N=37) and low anxiety (<44 and N=40) (Ercan et al., 2015). Using MANOVA, we

found a main effect of anxiety on HRV SDNN values (F (5,71) = 2.47, p=.048, Wilk's lambda = .88, η^2= .12). However, the low and high anxiety groups showed differences in HRV values only during cognitive tasks; N-Back SDNN ($F_{(1,76)}$ = 5.6, p= .021, η^2= .07), Simon SDNN ($F_{(1,76)}$ = 7.95, p=.006, η^2=0.1), and MST SDNN ($F_{(1,76)}$ = 4.63, p= .035, η^2=0. 06). Baseline and post task HRV values were not significantly different between anxiety groups (Figure 1).



/Figure 1: HRV measured using SDNN at various instances .

We explored the effect of anxiety on cognitive tasks by conducting a MANOVA with anxiety as a factor (low, high) and performance on n-back, MST, and Simon's task as dependent variables. There was a significant and substantial effect of anxiety on the n-back performance ($F_{(3,75)}$ = 3.37, p=.023, Wilk's lambda = .88, η^2=.12). Further, anxiety affected performance only for the 2-back condition ($F_{(1,76)}$ = 5.73, p=.05, η^2=.05) suggesting that effects of anxiety emerged as the cognitive load increased (Figure 2). Anxiety did not affect performance on other cognitive tasks.



/Figure 2: Effect of anxiety across different conditions of the n-back task

Discussion

Our study explored the effects of trait anxiety on cognitive performance and HRV. Trait anxiety scores were negatively correlated to HRV SDNN values, which suggests that as anxiety increases, the variability in heart rate decreases. Higher variability in heart rate is a sign of better health, which may be compromised in those with higher anxiety. Although,

there were no differences in resting HRV in high-anxious and low-anxious individuals, they showed differences in HRV during cognitive tests. One possible explanation is that cognitive tests increase cognitive load, which can trigger sympathetic nervous system (SNS) activity (Chatain et al., 2019). High-anxious individuals already exhibit elevated SNS activity which may limit additional SNS activation during cognitive tasks compared to non-anxious individuals, and as reflected in HRV metrics like SDNN (MacPherson et al., 2016; Stone et al., 2020). Anxious individuals may show a lower degree of variability in heart rate across cognitive tests due to their pre-existing elevated SNS activity.
We also observed a significant difference in cognitive performance between highanxious and low-anxious individuals during the 2-back task but no difference in 0-back or 1back task. This suggests that the difference in cognitive performance between the anxiety groups became apparent as the cognitive load increased. It also indicates that young adults can manage cognitive load up to a certain level, enabling both high-anxious and low-anxious individuals to perform optimally under lower cognitive demands. This was demonstrated by the lack of differences in performance on other tasks with low cognitive demands such as
MST and Simon's task. The effects of anxiety in young adults may not reflect in their performance on simple cognitive tests which may mask the status of their mental health (Godall et al., 2019). These effects need to be replicated in other tests with varying cognitive demands to confirm our findings.

Overall, our results suggest that heart rate variability could be a useful tool to understand the physiological differences between anxious and non-anxious young individuals. While high-anxious individuals may perform similar to low-anxious individuals in tasks with low cognitive demand, their performance and physiological responses may differ under higher cognitive load.

Session 3

Testing the impact of Reduced Mind Wandering on Response Inhibition

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Introduction

In our constantly changing environment, we often need to stop responses that are no longer necessary or are inappropriate, this ability called response inhibition[1]. The importance of response inhibition is exemplified in clinical populations, for example, Tourette's patients, where we see the inability to suppress unwanted movements. Thus, understanding the brain mechanisms that mediate response inhibition is crucial for developing effective therapeutic interventions. Response inhibition is often studied in the lab using the stop signal task[2]. In this task, participants must respond when a go cue is presented. In a random minority of trials, when a stop cue (e.g., an auditory tone) follows the go cue after some delay, participants are expected to not respond. The time taken to stop the response, stop signal reaction time (SSRT), cannot be directly measured and must be estimated using a mathematical model. It has been hypothesized that this duration, called SSRT, encompasses two sequential stages: a trigger and a brake. The trigger stage engages attentional and decisional networks[3], followed by the brake stage, which is responsible for the actual cancellation of the response. Matzke et al. (2017) proposed a model that estimates the percentage of trials in which, failure to stop occurs due to the brake not being 'triggered' (TF %), a phenomenon referred to as trigger failures (TF)[4]. Skippen (2020) proposed N100 ERP, reflecting early attentional processing[5], as a neural metric of TF. The brake stage presumably involves a cascade of activity within the pre-frontal cortex – basal ganglia – primary motor cortex circuitry with the onset of increased amplitude of beta frequency (13-30 Hz) over the right pre-frontal cortex[6].

Studies on response inhibition neural circuitry often assume complete focus during tasks, yet this is unrealistic in everyday life. Mind Wandering (MW), where attention drifts to task-unrelated thoughts, occupies up to 50% of our waking hours[7], diminishing sustained attention and performance[8], suggesting that MW may have a detrimental impact on response inhibition. Consistent with this, a behavioural study[9] on healthy adults observed that during periods of MW compared with on-task, both TF% and SSRT were higher. Other studies on post-traumatic stress disorder[10] and attention deficit hyperactivity disorder patients also corroborate the potential link between increased MW and poorer response inhibition (increased SSRT)[11]. This suggests that interventions that reduce MW may improve response inhibition. Here, we test this using meditation as an intervention. This is based on previous research which has observed that mediation reduces the episodes and depth of MW[12] and improves response inhibition[13].

Method

This ongoing study compares long-term meditators to age-matched controls with no prior meditation experience. We will recruit 40 volunteers for the study, comprising 20 long-term meditators and 20 control subjects. Participants perform the Stop signal task with 25% of random stop signal trials. Intermittently, when probed, they will report their mental state (on-task or mind-wandering). During the task, EEG data will be collected to measure the beta band activity. Thus far, data has been collected from two meditators and four control participants. However, two control participants were excluded from the analysis due to suboptimal task performance.

Result

Initial comparisons indicate a typical outcome, that meditators exhibit a numerically lower Stop-Signal Reaction Time (SSRT) and a reduced mean Go Reaction Time (Go RT) compared to controls (see Table 1).

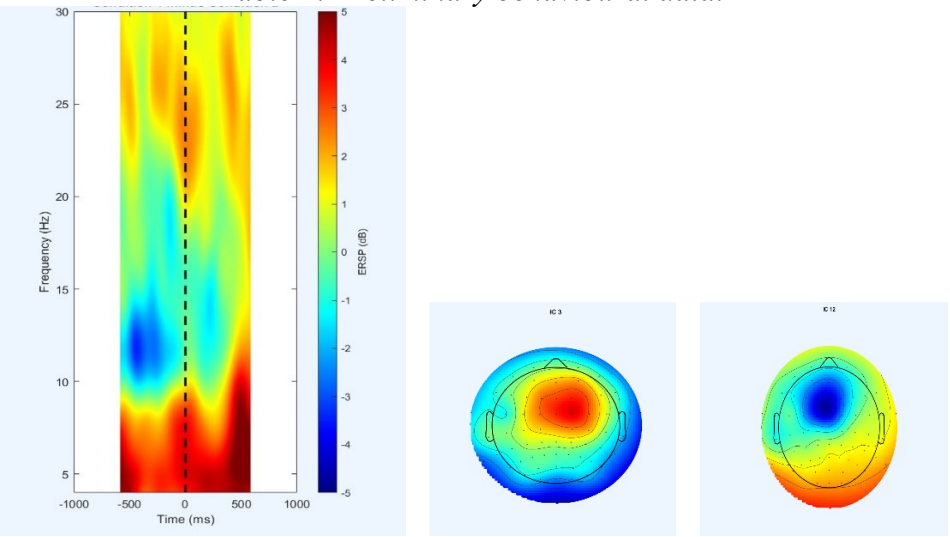
The EEG data collected was subjected to preprocessing, it underwent bandpass filtering and line noise filtering. Noisy channels and noisy stretches of data, identified through visual inspection, were excluded from further analysis. Following artifact removal, the data were subjected to Independent Component Analysis (ICA) to decompose the EEG into temporally independent components. Each independent component (IC) was visually inspected, and components representing non-neuronal artifacts were discarded. The remaining components were evaluated, and the right frontal independent component (RF IC) was identified based on its spatial topography, time-course, and frequency characteristics, consistent with known frontal brain activity. This component identified in each participant was then used in subsequent analyses. We first compared the activity of the RF IC in the stop trials of the meditator to that of controls (Fig 1). Then we compared the activity of the RF IC of the meditator in the stop trials while they were on task with the trials when they were mind-wandering (Fig 2). This comparison was not conducted on controls as there were very few mind-wandering episodes reported.

Since this is an ongoing study, it is premature to draw conclusions.

Tables and figures:

	Meditator (n = 2)	Control (n = 2)
SSRT	395.85 ± 10.5 ms	400.45 ± 8.4 ms
Mean GoRT ± SEM	562.746 ± 7.469 ms	646.743 ± 6.89 ms

Table 1: Preliminary behavioural data.



/ / /Figure 1: Comparative ERSP plot for Meditators (n=1) (condition 1) vs Controls (n=2) (condition 2) in all the stop trials and the topography map of the right frontal independent component of controls that is selected for analysis.

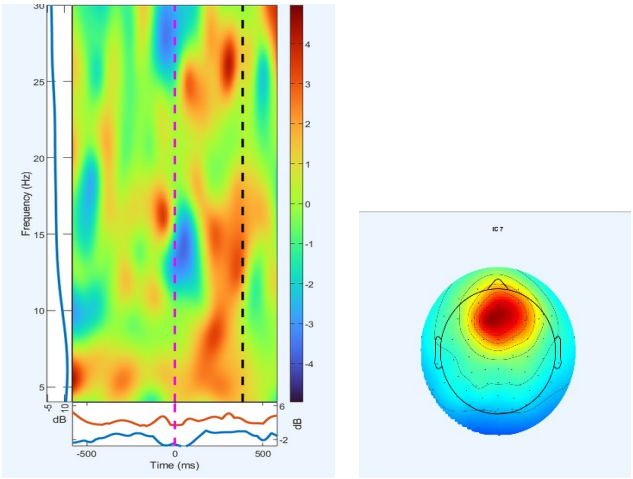


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Figure 2: Comparative ERSP plot for On task (condition 1) vs Mind Wandering (condition 2) in all the stop trials in the meditator participant, time locked to the stop cue and the topography map of right frontal independent component of the meditator that is selected for analysis.

Discussion

This ongoing study hypothesizes that meditators would experience a lower frequency of MW and improved response inhibition as compared to non-meditators. Moreover, improved response inhibition would be elicited during the on-task episodes compared to mind wandering. These findings emphasize the importance of understanding the underlying neural mechanisms, and the impact of mind wandering on response inhibition, which may help in the development of therapeutic interventions for clinical individuals with deficits of response inhibition.

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Differential effects of arm and finger posture on Tactile Enumeration

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Introduction

Tactile enumeration is the process by which we perceive the number of stimuli obtained via touch. To determine the number of stimuli on the skin, one must integrate information across different regions of the body. A factor that can affect enumeration is the localization of the body in space. During localization, the brain assumes that our limbs are present at certain external locations with respect to our body (such as assuming that the right hand is on the right side of the body midline), called canonical postures (Aglioti et al., 1999). They allow us to efficiently compare the internal somatotopic activations when touch is provided to some part of the skin with the external location of that part in space. Combining the internal and external locations gives us the complete location of the touch. Violating these assumptions by placing limbs in non-canonical postures (right arm on the left side of the midline) reduces localization accuracy (Tamè et al., 2019). We were interested to see whether these posture effects affect the integration of information across the body during enumeration. We were especially interested if the different canonical positions affect enumeration differently. The presence of posture effects would imply that despite not requiring the explicit location of touch in order to judge their number, localization does play an important role in enumeration.

Methods

Participants (n = 27, mean age = 20.5167, SD = 1.81) performed an enumeration task where they had to report the number of stimuli (range: 1-8) delivered to their fingers. The participants sat with their hands palm-side down on a table with vibrators (8mm coin motors) attached to their fingers, excluding thumbs. In a trial, a random number of motors activated simultaneously for 700ms (frequency: 250hz), preceded by a flashing LED as a visual cue (500 ms) by 500 ms (Cohen et al., 2014). Participants were instructed to verbally report the number of stimuli they perceived as quickly and accurately as possible. Their responses were recorded using a microphone and Response Times (RT) and Response Error Rate (RER) were calculated. Participants performed this experiment in three postures: Normal (hands placed at shoulder width), Cross-mid (hands crossed across body midline), and Intertwined (fingers intertwined, hands at body midline), with the Normal being our control. The order of the postures was counterbalanced, and each condition had 120 trials divided into two blocks, with each numerosity being presented 15 times. Participants placed their hands on a soft towel, and breaks were given between blocks to prevent finger strain and discomfort.

Results

We found that Response Error Rates (RER) and Response Times (RT) varied significantly with respect to posture. We performed a repeated measures ANOVA, taking posture as the main factor and numerosity as the between-subject factor. For RER, we observed a significant effect of posture $F(2, 416) = 72.324$, $p < 0.001$, $\eta^2_p = 0.258$, numerosity $F(7,208) = 74.655$, $p < 0.001$, $\eta^2_p = 0.715$, and a significant interaction between numerosity and position $F(14, 416) = 2.946$, $p < 0.001$, $\eta^2_p = 0.09$. Post hoc comparisons showed that error rates in Normal posture were significantly lower than in Crossmid (mean difference = -4.537, $p < 0.001$) and Intertwined postures (mean difference = -15.062, $p < 0.001$), and that Crossmid values were significantly lower than Intertwined values (mean difference = -10.525, $p < 0.001$). We performed the same test for RT values. We observed a significant effect of posture $F(2, 1108) = 6.856$, $p < 0.001$, $\eta^2_p = 0.012$, numerosity $F(7, 554) = 51.674$, $p < 0.001$, $\eta^2_p =$

0.395, and a moderate interaction between numerosity and posture $F(14, 1108) = 1.945$, $p = 0.019$, $\eta^2_p = 0.024$. Post hoc comparisons showed that RT values for Normal posture were significantly lower than for Intertwined (mean difference = -0.098, $p = 0.013$) but not significantly different than Crossmid ($p = 0.704$). Crossmid values were significantly lower than Intertwined values (mean difference = -0.083, $p = 0.004$). Overall, performance was the highest in the Normal posture, followed by Crossmid and Intertwined. We also observed that participants tended to underestimate numerosities across all postures.

Discussion

Our results show that even when explicit localization is not required, enumeration is affected by posture. We also see that intertwining fingers has a stronger effect than crossing arms. One explanation can be that localization occurs for every touch, whether the task context requires it or not. However Badde et al. (2015) show that posture effects are affected by task context, and tasks that do not require reporting external spatial locations show lowered posture effects. This implies that posture effects do have a component dependent on the requirement of external localization. The fact that Intertwined effects are more severe than Crossmid implies that posture effects occur in discrete levels; crossing the arms has a weaker effect than crossing the fingers. Similarly, our experiment requires perceiving stimuli presented to the fingers, which maintain a relative canonical posture of being next to each other in the Crossmid condition, something that is violated in the intertwined condition. The maintenance of relative canonicity could explain why Crossmid's performance is better than that of the intertwined posture.

The effect of word order in modulating visual attention during spatial language comprehension

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Introduction

Space is a basic human experience (Gosztonyi, 1976). All humans map their shared understanding of spaces based on their world knowledge using 'projective' spatial terms such as 'above', 'to the right' etc. Past research shows that comprehension of this spatial language engages attention (Carlson & Logan, 2005; Logan, 1994).

A strategy to understand how overt attentional mechanism is simulated to understand patial relation between two objects is given by the Attentional Vector Sum (AVS) model8. It is a computational cognitive model that predicts the direction of attentional shift in apprehension of spatial terms 7. It works by computing goodness of fit of spatial template, how good or poor the located object is placed with respect to reference frame. For example, for the spatial description, "The bulb is above the jug", 'the bulb' - located object, 'the jug' - reference object, and 'above' - spatial relation between the two objects. According to the AVS predictions, visual attention shifts from reference object (jug) to located object (bulb). Although the AVS model suggests the direction of attentional shift, it is yet not clear 'when' in time this shift happens.

A more ecological approach to studying spatial term comprehension is using the Visual World Paradigm (VWP), where participants listen to spoken utterances while simultaneously looking at a scene/text. For the description, "The bulb is above the jug", VWP posits an incremental interpretation of the referents as and when they are uttered in a sentence, i.e., attentional shift happens from the located object (the bulb) to the reference object (the jug) in real time.

Previous research 82 tested the AVS predictions for English and German sentences respectively, both of which exhibit Subject-Verb-Object (SVO) as the dominant word order - the spatial term occurs between the located and the reference object in the spoken sentences with the format: "The [located object] is [spatial preposition] the [reference object]".

The present study aimed at understanding the time course of AVS predictions if the position of spatial term and order of mention of referents (located and reference objects) is altered in a spoken sentence.

We used Hindi spatial language in a visual world setting to test the AVS predictions. Hindi, a relatively free word order language, gave us the flexibility to alter the order of referents in the sentences describing spatial relation. We used canonical and noncanonical structures which provided us with an ecological condition to check divergence in the AVS predictions using VWP.

We found that irrespective of the order in which referents are mentioned (canonical vs. non-canonical), the AVS predicted shift in visual attention is observed from the reference object (RO) to the located Object (LO). We also found that AVS predicted gaze shift is closely time-locked to the utterance of spatial term and is facilitated by genitive case marker (के) in Hindi.

Method

46 Hindi native speakers (average age = 19.87) were divided into two groups of 23 each - one group participated in canonical word order condition; the other in non-canonical word order condition.

A display containing three vertically aligned objects (located, reference, competitor) along with a spoken utterance constituted the stimulus in the experiment. Two auditory sentences –

one canonical and one non-canonical were recorded for each scene by a female native Hindi speaker, sampling at 44100 Hz, where only the reference and the located objects were mentioned (competitor was not mentioned). Critical time windows (onsets and offsets of noun phrase 1, noun phrase 2, spatial term) were marked for later analyses.

Canonical: "[located object] [reference object] के [spatial term] है" (बल्ब जग के ऊपर ह।ै)

Non-canonical: "[reference object] के [spatial term] [located object] है " (जग के ऊपर बल्ब है।).

32 triplets (mean = 1.54, SD = 0.09) were chosen for creating critical stimuli after double rating study (N=20) on a 5-Point Likert Scale for name, frequency and familiarity of object in the pictures (mean frequency = 4.58, SD = 0.23; mean familiarity = 4.85, SD = 0.11), followed by triplet rating (N=20) on a 5-Point Likert Scale for similarity in shape, semantics, phonological onset and functional relatedness.

Animacy factor was balanced across trials. Pictures were resized on white background.

The Experiment had 92 trials (32 critical + 60 fillers) - sentence picture verification task. Each scene included three objects- located object (e.g., bulb), reference object (e.g., jug) and competitor (e.g., snake). For both the word orders, it was 2 x 2 factorial design – two within group factors with 2 levels each - spatial term ("ऊपर" above vs. "नीचे" below) and sentence value (match/congruent condition: objects displayed according to their spatial description vs. mismatch/incongruent condition: objects not displayed according to their spatial description). The location of 3 objects was based on a 5 x 6 virtual grid (invisible to the participants) on the screen 2.

Fillers had different sentence structure and other spatial terms such as near, between, etc. Item-condition combinations were randomised. Each participant did either canonical or non-canonical list and saw only one version of an item, and the same number of trials for each condition in each list.

Participants' monocular eye movements were recorded at a frequency of 1000 Hz using an EyeLink 1000 Plus (SR Research). Eye gaze and Response times were recorded using the SR Research Experiment Builder (v2.4.193) (2020). They were instructed to understand the sentences and inspect the picture and respond per button press whether the sentence matched or didn't match the picture, only after the end of the sentence. Standard 9-pt. calibration-validation of the eye tracker was performed at the start of the experiment, and a second calibration after half experiment. Each trial began with a central fixation point for 1500 ms, followed by the picture and the sentence presentation. A blank screen (ISI) of 2500 ms after response ended the trial.

Experiment lasted for 20 mins.

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Results

RTs - analysed only for the correct responses; trials with incorrect responses (29.68 % for canonical group; 21.71 % for non-canonical group) were removed before analysis. No significant difference was seen in RTs with spatial term (ST) and sentence value (SV) as fixed factors for both the groups.

Mean Fixations analysis was done only for matching trials with correct responses. During analysis, the data was collapsed across spatial terms, "ऊपर" and "नीचे". The visual scene was divided into 4 Areas of Interest (AoIs) – one for each of the three objects (located object (LO), reference object (RO), competitor (C)) and the background (BG).

Critical time windows for each word was calculated on a trial-by-trial basis. Canonical sentence: NP1 (Mduration = 520.44), NP2 (Mduration = 439.88), P (Mduration = 467.19). Noncanonical sentence: NP1 (Mduration = 572.88), P (Mduration = 541.94), NP2 (Mduration = 534.69). Mduration for CM was taken to be 200 ms before spatial term onset for all the

sentences. A time course binning analysis (100 ms time bins) from scene onset to key response was done to examine the time course of visual attention across the sentence. Fixation percentages on the 4 AoIs within 4 critical time windows NP1, NP2, CM, P for canonical and NP1, CM, P, NP2 for non-canonical sentences were calculated after averaging across all trials and participants. A repeated measures ANOVA was performed to compare the effect of critical time window of each word (NP1, NP2, CM, P) in the sentence on average looks to areas of interest (LO, RO, C, BG).

For the canonical group, the main effect of time window of word was not significant, while that of areas of interest was significant, $F(3,66) = 285.78$, $p < .001$, $np2 = 0.806$.

There was also a significant interaction between the two, $F(9,198) = 21.59$, $p < .001$, $np2 = 0.394$.

The results show that participants begin by fixating towards LO first as it corresponds to NP1, followed by gradual increase in the fixations towards RO as NP2 is mentioned.

A marked rise in fixation proportion towards RO is observed at the genitive case marker (के) as the function of genitive case marker is to specify relation between the two NPs. However, a shift back to LO is seen after case marker + spatial term onset has begun. Increased number of inspections towards the LO after the mention of RO followed by case marker, shows verification of the spatial location of the LO with respect to the reference object. This pattern of gaze corroborates AVS prediction (a shift from RO to LO after listening spatial term).

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For the non-canonical group, the main effects of time window, $F(3,66) = 4.58$, $p = .006$, $np2 = 0.008$ as well as areas of interest, $F(3,66) = 420.79$, $p < .001$, $np2 = 0.860$ were significant. Their interaction was also significant, $F(9,198) = 50.29$, $p < .001$, $np2 = 0.576$.

As the participants hear NP1, the fixations start getting directed towards RO and significantly increase during CM (के) time window. By the time spatial term onset begins, gaze shift has already been launched as Hindi genitive case marker (के) facilitated the prediction of the other referent (LO in this case). Hence, the case marker is said to cue the prediction of the located object. A marked increase in number of fixations towards LO is seen after spatial term onset and it continues to be fixated as it is mentioned. This shift from RO to LO after spatial term onset supports the AVS prediction.

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Discussion

The ultimate goal of studying visual attention in different word orders was to account for the AVS predictions in a visual world. The AVS suggests a gaze shift from reference object (RO) to the located object (LO) but doesn't say anything about the time course of this shift. Whereas visual world advocates incremental processing so shift should be in the order in which referents are mentioned, irrespective of it being LO or RO.

The results from both canonical and non-canonical group support the attentional shift predicted by AVS even though the orders of mention of both the objects were different. We also see the gaze shift occurs at a later stage in canonical group while at an early stage in the non-canonical group as case marker + spatial term occurs later for canonical condition and vice versa for non-canonical condition. This implies that AVS predicted gaze shift is closely time bound to utterance of spatial term. Future directions might include investigating which of this order of mentions is more efficient when it comes to spatial language comprehension.

Our study checks for cross-linguistic validity and applicability of the predictions of the AVS model. Secondly, this study adds to the theory that grounds language in the perceptual world and their interaction.

Hindi-Urdu Causative Event Structure Acquisition

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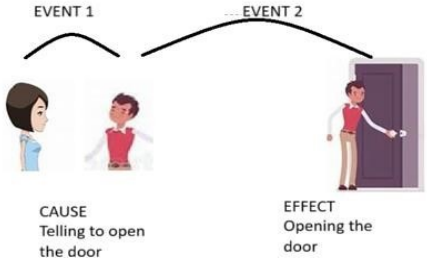
Human cognition can tap into 'causality' as a time-space pattern and encode event structures in languages in many different ways. Causative structures are of particular interest because they encapsulate the relationship of cause-effect by employing various strategies such as the agency of participants in the events related by cause-effect, the number of participants (implicit/explicit), and interdependence of events (one happening after the other).

Hindi-Urdu uses morphology to embed one or more events in a single sentence, using causative morphology.
For example:

1. Direct causative (DC) event structure laRke=ne darwaazaa khol-aa. Boy =erg door open.DC-pfv A boy opened the door.	 /
2. Indirect causative (IC) event structure mitaa=ne laRke=se darwaazaa khul-vaa-yaa. mitaa=erg boy=inst door open-IC-pfv Mitaa made the boy open the door.	 /

In indirect causative, it is impossible that the effect 'door opening' could have happened before the cause 'Mitaa instructing the boy'. Decoding Hindi-Urdu causative structures requires children to acquire:

1. Verb subcategorization frames (intransitive, transitive, ditransitive, and causative) (Narasimhan, 2006) (cf. Table 1)
2. Role of participants involved and so usage of case marking (agent-*mitaa*, intermediate agent-*boy*, patient-*door*) (Tomasello, 2008)
3. Varying morphological forms of verbs across a variety of sentences (-AA, Null, No change) (Bhatt and Embick, 2017)
4. Semantic verb classes restrictions on causative structures (khil '*bloom'*, **khil-aa*(DC), **khil-vaa*(IC)) (Srishti, 2008)

To study the acquisition of causative event structures, we examined approximately 500 utterances produced in natural settings by 6 children from age 1;2 to 6. Select illustrative examples of children's productions are presented in Table 2.

TABLE 2: DATA FROM CHILDREN'S PRODUCTIONS	
1-2 years	
i. V(1;4): DC of intransitive, unaccusative **khol-**o! open.DC-imp 'Open (it)!'	ii. N(1;7): DC of intransitive, unergative (bhaai/mumma) **baith**! (brother/mother) sit.imp Intended: 'Make me sit!' Expected form: **biTh-aa**
2-3 years	
iii. V(2;4): DC of intransitive, unaccusative mammaa=ne **ban-aa-**yaa house mother=erg make-DC-pfv house 'Mother made the house.'	
3-5 years	
iv. P(4;6): DC of transitive, ingesto-reflexive mammaa, khaanaa **khaa**-o mujhe mother food eat.DC-imp I.dat Intended: 'Mother, feed me food!' Expected form: **khil-aa**	v. P(4;6): Ditransitive mujhe doodii de do I.dat milk give give.imp 'Give me milk.'
5-6 years	
vi. V(5;10): IC counterpart of transitive sab mujh=se kaam **kar-vaa**-te hEM all I=inst work do-IC-hab be.prs 'Everyone gets work done by me.'	vii. V(5;11): Nonvolitional Change of State V vo **sharm-vaa** de-taa hE He shy-IC give-impf be.prs Intended: 'He makes me shy.' This verb cannot be causativized: ***sharm-vaa**

We observed that children as early as 1 year and 4 months old used intransitives and DCs of intransitives in imperative sentences, see (i). They could identify and produce the 'causer of an event' (the agents). However, DC forms were not always uttered in an adult-like fashion and were mostly item-based, see (ii). At ages 2 to 3, occurrences of DCs were observed in varied morphological (-aa suffixation and vowel change) and semantic verb classes (verbs of disappearance, motion, and perception) in affirmative and interrogative sentences. Children could correctly express the roles of the event participants and map them to the appropriate case marking, e.g. ↔ agent, see (iii). At the ages of 3 to 5, children used DCs in a more adult-like fashion, but not for all verb classes. In (iv), we see faulty verb alternation for the DC of the ingesto-reflexive verb root – the child uses the form *khaa* 'eat' instead of *khilaa* 'feed'

even though other aspects of the syntax-semantics such as the participant role and case marking, e.g. =ko ↔ goal, are adult-like. Incidentally, by this age, the same child has acquired other simple ditransitive verbs such as *de* 'give', see (v). At age 5, the first correct occurrence of indirect causative morpheme is observed in the data along with intermediate agent role marking by *=se*, see (vi). However, children continued struggling with the IC of ingesto-reflexives and erroneously produced ICs of non-volitional change of state verbs at this stage, see (vii).

To summarize, the data in Table 2 highlights that the acquisition trajectory of causative events is not similar for all kinds of events. Production data suggests that children pass through various milestones by age 6 to 7, with the progress varying across different classes of verbs. The data patterns here showcase the increasing complexity of causative structures during various developmental stages.

TABLE 1: CAUSATIVE PARADIGMS (for background on causatives)

Verb	**Direct Causative**	**Indirect Causative**
ban 'make' (intransitive, unaccusative) ghar ban-egaa House make-fut 'A house will be made.'	*ban-**aa*** 'make' (transitive) piyaa ghar ban-aa-egii Piya house make-DC-fut 'Piya will make a house.'	*ban-**vaa*** 'cause somebody to make' piyaa ghar ban-vaa-egii Piya house make-IC-fut 'Piya will get a house made (by someone).'
khul 'open' (intransitive, unaccusative) Dabbi khul gayii Box open go.pfv 'The box got opened.'	*kh**o**l* 'open' (transitive) piyaa=ne Dabbi khol-ii Piya=erg box open.DC-pfv 'Piya opened the box.'	*kh**u**l-**vaa*** 'cause somebody to open' piyaa=ne raam=se Dabbi khul-vaayii Piya=erg raam=inst box open-ICpfv 'Piya made Aarav open the box.'
khaa 'eat' (transitive, ingesto-reflexive) piyaa=ne seb khaa-yaa Piya=erg apple eat-pfv 'Piya ate an apple.'	*kh**il**-**aa*** 'feed' (ditransitive) piyaa=ne raam=ko seb khilaa-yaa Piya=erg Ram=dat apple eat-DC-pfv 'Piya fed Ram an apple'	*kh**il**-**vaa*** 'cause somebody to feed' piyaa=ne miraa=se raam=ko seb khil-vaa-yaa Piya=erg Mira=inst Ram=dat apple eat-DC-pfv 'Piya made Mira feed Ram an apple.'
kar 'do' (transitive) piyaa kaam kar-egii Piya work do-fut 'Piya will do the work.'	-	*kar-**vaa*** / *kar-**aa*** 'cause somebody to do' piyaa raam=se kaam kar-(v)aa-egii Piya Ram=inst work do-IC-fut 'Piya will make Ram do the work.'

Understanding the temporal oddball effect: Investigating the role of repetition suppression and anticipation

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Introduction

When an unexpected event comes in between a series of similar events the unexpected event seems to pop out. This is known as the pop out effect of attention. Increased attentional processing is associated with subjective expansion of perceived time, also known as the oddball effect. This effect has been studied extensively and it's known that the subjective expansion of duration of the odd event or oddball progressively increases with the numbers of similar events after which the oddball is presented. One account says that this effect is due to the participant knowing that an oddball will be presented eventually and hence with each presentation of a similar event the anticipation of the oddball which results in heightened attention during perception of the target event (oddball or similar event), causing distortion in perceived duration. Another recent argument counters the role of repetition suppression as the possible explanation of the oddball effect. In the present study, we attempt to investigate the role of repetition suppression in the oddball effect by manipulating temporal attention using a temporal cue. The manipulation of when (early or late) to expect the oddball during the stimulus presentation will allow us to understand the role of repetition suppression in the absence of increasing anticipation with the presentation of each repeated stimulus.

Methods

Here we are presenting the data for a total of 8 participants (4 females, mean age = 23, S.D = 1.414) out of 20 planned (Data collection ongoing).

The stimulus was presented on a 120 Hz refresh rate screen color monitor. Stimuli consisted of a sequence of white circles followed by either a white (repeat) or a black (oddball) stimulus at the end of the sequence. The circle's stimuli subtended by 5.72^{o} x 5.72^{o}. The temporal location of the target (oddball or repeat) was cued at the beginning of each trial. The cue was either Red, Yellow or Green indicating the target appeared early, middle or late respectively. Then a gray screen with a blue question mark (?) appeared where participants reported their response (see fig. 1). In each trial the participants reported if the duration of target was shorter or longer then the preceding repeated events.

All standard events appeared for 500 ms and the duration of test events varied from 300-700 ms with a step size of 67 ms. The interstimulus duration (duration between two consecutive events) was 300 ms. The length of the sequence varied from 2-8 (2, 3,5, 7, 8) and appeared in random order ensuring that the participant does not know the exact length of the sequence but knows the exact location of the target event indicated by a cue which could be valid or invalid (75-25). There were a total of 35 different trials (7 duration x 5 events) in the valid condition. The experiment consisted of a total 2 sessions of 6 repetitions (3 oddball and 3 repeat) of 35 trial types, resulting in a total of 210 trials in each session and 420 trials in the experiment for the valid trials. The invalid trials were matched and 70 trials were added to each session for a total of 140 trails. This way, the total number of trials including valid and invalid conditions sums up to 560 trials.

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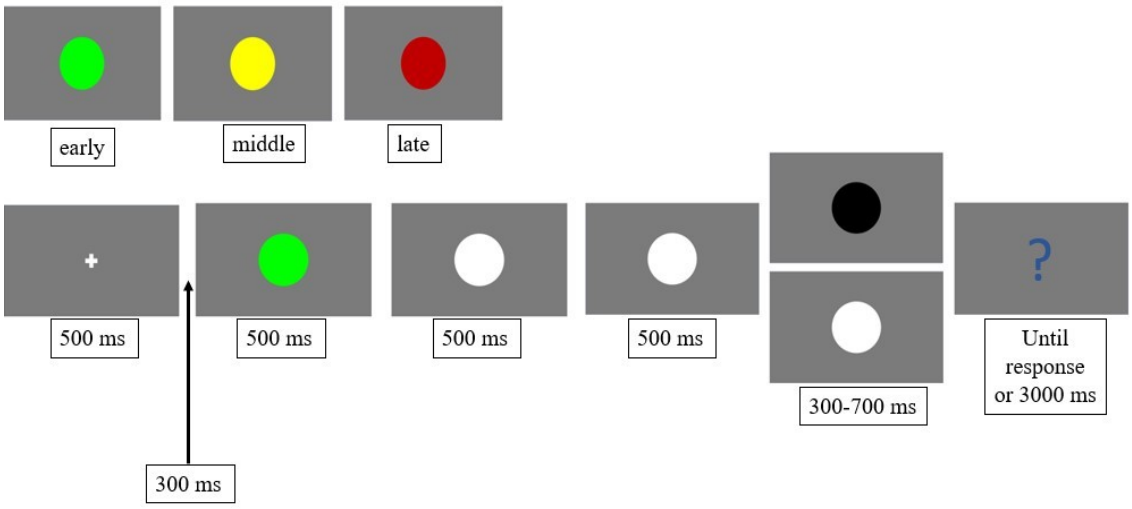

Fig 1. Illustrates the trial sequence from a 3 event trial. Each sequence starts with a fixation followed by a coloured circle indicating the length of the sequence. The cue can be valid or invalid, in this figure, valid. The participant has to report at the blue question mark by pressing 'L' if they felt the target was Longer and 'S' if shorter.

Results & Discussion

The results showed that the DDF (Duration Distortion Factor, the ratio of Standard duration(i.e. 500 ms) and Point of Subjective Simultaneity (PSE)) for oddball were greater than 1, and less than 1 for repeat events suggesting expansion of perceived duration for oddball target and contraction for repeat trials and this was consistent in all events as seen in fig 2. This finding is inline with the previous findings of Pariyadath and Eaglemen (2007, 2012) supporting the repetition suppression account of the oddball effect. Further the finding is in contradiction to Saurels et al. (2023) which showed a DDF > 1 for both oddball and repeat event. We used a
linear mixed model to examine the relationship between DDFs and the number of repeated events preceding oddball and repeat tests . The results showed a significant effect of Trial type (Oddball or Repeat) and main effect of event. However, the interaction effect was not significant. Further the mean DDF for oddball (M= 1.039, SE= 0.025) is significantly higher than repeat (M= 0.884, SE= 0.024).

Saurels et al.(2023) claim that the subjective expansion of oddball is due to increased anticipation and attentional focus with the presentation of each repeating event and not due to repetition suppression. However, one major issue with their design was that participants in their study knew exactly when an oddball would eventually appear by the countdown on the stimuli. This could have made participants pay less / no attention to the preceding events except the penultimate event. In the present study we attempted to account for the role of repetition suppression in the oddball paradigm by removing anticipation of the target stimulus but still ensuring they attend to each repeated event through invalid trials. This allowed us to ensure that along with manipulating the number of preceding events and removing the anticipation for the target, the participants attended to each repeated stimulus in the trial. This was further ensured by checking the accuracy in the invalid conditions.

The value of DDF for 2 event condition (see fig 2) when oddball was presented is lower than

1(0.941). This observation may be explained by participants having only 1 previous event to judge the target event with and hence having lower accuracy and being unprepared. Further, we observe a Ceiling effect of DDF between 5 and 7 events in both oddball and repeat trials, a similar trend as seen in Saurels et al. (2023), indicating that the effect of Repetition suppression is possibly limited to a certain no. of repeat events.

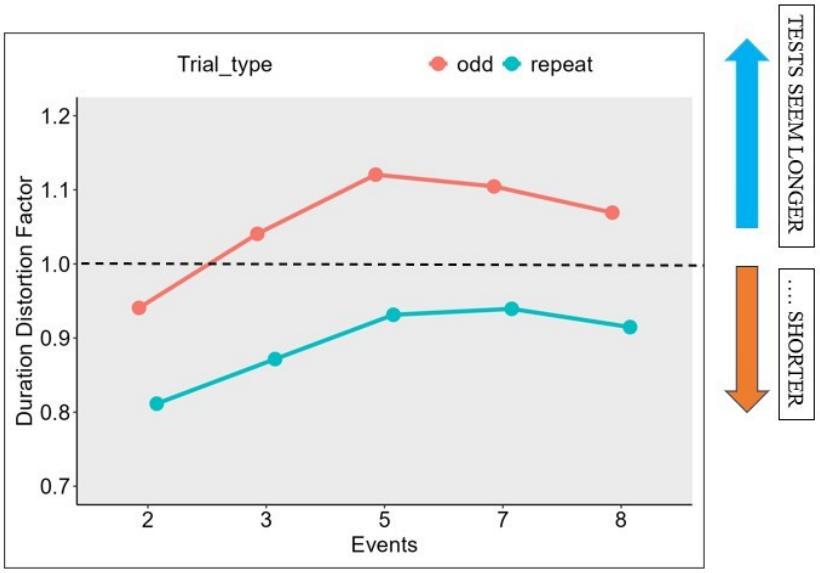

Fig 2. DDF values plotted against the number of preceding events. A DDF greater than 1 indicates subjective expansion.

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The Impact of Metacognitive Awareness and Cognitive Flexibility on Pattern Recognition Task Performance

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Introduction

In today's world-characterized by technological advancement at an unprecedented pace and the abundance of information available to us-effective management of cognitive resources has become a determining factor for success. Among the aforementioned cognitive resources, multitasking is one that holds particular importance. The pandemic has accelerated the need for multitasking, as people have had to adapt to new ways of working and learning, often balancing multiple tasks simultaneously. This shift, however, has introduced substantial challenges, particularly in terms of memory retention and attentional control, leading to a decline in overall task performance (Moreno et al., 2020; McWilliams, 2023).

Within this context, cognitive abilities such as metacognition—the awareness and regulation of one's own cognitive processes—and cognitive flexibility—the ability to adapt one's thinking and behavior in response to changing circumstances—have become increasingly important. Akama's (2004) study offers valuable insights into how metacognitive experiences, such as self-monitoring and self-regulation, play a pivotal role in enhancing problem-solving abilities. These findings suggest that metacognition is not just a passive awareness of one's cognitive processes but an active driver of task performance, particularly during transitions between tasks. The ability to monitor and adjust one's approach to a task can significantly influence outcomes, especially in environments where multitasking is required.

However, the relationship between metacognition and task performance is complex and not always straightforward. While positive metacognitive beliefs—confidence in one's cognitive abilities and strategies—are crucial for effective performance, negative thoughts associated with metacognitive awareness can lead to poorer outcomes. Moreno et al. (2020) emphasize that the quality of metacognitive beliefs can have a profound impact on how well individuals perform tasks, especially under conditions of cognitive strain. This highlights the dual-edged nature of metacognition: while it can enhance performance, it can also hinder it if not properly managed.

Cognitive flexibility, on the other hand, is increasingly recognized as a key factor in promoting healthy metacognitive processes and overall psychological well-being. Research by Aydin and Kaynak (2021) reveals a negative correlation between cognitive flexibility and dysfunctional metacognition, suggesting that individuals who can adapt their thinking and behavior more readily are less likely to experience the negative effects of poor metacognitive regulation. This finding implies that fostering cognitive flexibility could serve as a protective factor against the detrimental effects of dysfunctional metacognition, thereby enhancing both cognitive performance and mental health.

Given these complications, the present study tries to examine the effect of metacognitive awareness on the task performance, this time limiting its scope to pattern recognition tasks. Further the study evaluates the potential moderating role of cognitive flexibility between aforementioned variables. The study will examine the effects of these interventions in both single-task and multitasking conditions to give a full account of exactly how metacognition and cognitive flexibility interact with task performance in the complex cognitive ecology of modern society.

Method

A true experimental design including the experimental group and control group was employed to evaluate the impact of a guided imagery based metacognitive intervention on a recognition-based task performance and to assess the moderating role of cognitive flexibility. There was a total of 60 participants who were selected using simple random sampling. The participants were equally assigned to the experimental and control conditions with 30 participants in each group. The study was conducted in a Controlled lab environment using a computer-based task switching paradigm (Stoet et al., 2013), a guided imagery-based metacognition intervention video (McGraw Hill PreK-12, 2022), and cognitive flexibility scale (Martin & Rubin; 1995). After obtaining the pretest scores on the computer-based task switching paradigm (Stoet et al., 2013) the experimental group received metacognitive intervention involving guided imagery video followed by a distractor task (origami). The control group completed similar tasks without metacognitive intervention. The post test scores were measured twice immediately after the distractor activity and 48 hours later. The statistical analysis including paired and independent sample t test along with, Shapiro-wilk normality, were used to compare the between group and within group Multitasking and single tasking conditions along with task switching accuracy.

Result

Result showed a significant improvement in reaction time for pure task (M=762 ms ; SD= 91ms) and mixed trials (M=872 ms; SD=104 ms) post intervention, suggesting enhanced performance due to metacognitive training. Cognitive load theory and dual process theory support these findings, highlighting improved cognitive resource management and error detection. Task switching cost reduced by 24% indicated effectiveness in multitasking environment. There was no significant difference found between high (M= 21.3; SD = 4.7) and average (M = 20.1; SD = 5.2) cognitive flexibility. Overall, the metacognitive intervention has shown to increase the performance in task.

Conclusion

Understanding the importance and relationships of metacognitive awareness on task performance and its impact on cognitive flexibility will inform the design of educational and cognitive training programs that leverage metacognitive strategies and cognitive flexibility to improve learning outcomes and problem-solving abilities.

Gaze and Gluttony: How Weight Shapes Our Initial Food Fixations

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Abstract

This study investigates the orienting behaviour towards high-calorie processed versus low-calorie whole food stimuli in individuals with different Body Mass Index (BMI) categories. Using eye-tracking methodology and the free-viewing paradigm, participants with high BMI and normal BMI were exposed to high- and low-calorie food images presented in different visual fields. Four measures—probability of first fixation (PFF), entry time, dwell time, and fixation count—were analyzed to understand the attentional biases towards these stimuli. The results indicate that high BMI participants are more likely to first fixate on high-calorie foods, especially when these images are presented in the left visual field, suggesting a possible right-hemisphere bias for high-value stimuli. These findings align with previous research on the hemispheric processing of high-value stimuli.

Introduction

Attention and visual processing play crucial roles in how individuals perceive and respond to environmental stimuli. Previous research has shown that individuals with higher BMI tend to exhibit a bias towards highcalorie foods, which may contribute to unhealthy eating behaviours and weight gain (Nijs et al., 2010; Castellanos et al., 2009). Understanding the neural and cognitive mechanisms underlying these biases is critical for developing interventions aimed at mitigating their impact.

Previous research by Gupta et al., 2019 has demonstrated that high-value stimuli, such as high-calorie foods, are often processed preferentially by the right hemisphere of the brain. This right-hemisphere bias may manifest in visual tasks as a tendency to first fixate on stimuli presented in the left visual field, which is processed by the right hemisphere. This study aims to explore whether such a bias exists in individuals with varying BMIs and how it influences their orienting behaviour towards high- and low-calorie food images.

Methods

Participants

39 subjects (21 males) aged 18 to 42 participated in this study. They were categorized into two groups based on their BMI: high BMI (≥25; n=19) and normal BMI (=18-25; n=20). All participants had normal or corrected-to-normal vision and were free from any neurological or psychiatric conditions that could affect visual processing.

Materials and Procedure

The study used an eye-tracking free-viewing paradigm. Participants were seated in front of a computer screen, and their eye movements were recorded using Eyelink 1000 Plus desktop mount with a sampling rate of 1000Hz. During the experiment, participants were presented with pairs of food images—one highcalorie and one low-calorie—simultaneously positioned in left and right visual fields (5° from the centre).

The central task involved a letter discrimination task to ensure that attention was not overtly directed towards the food images.

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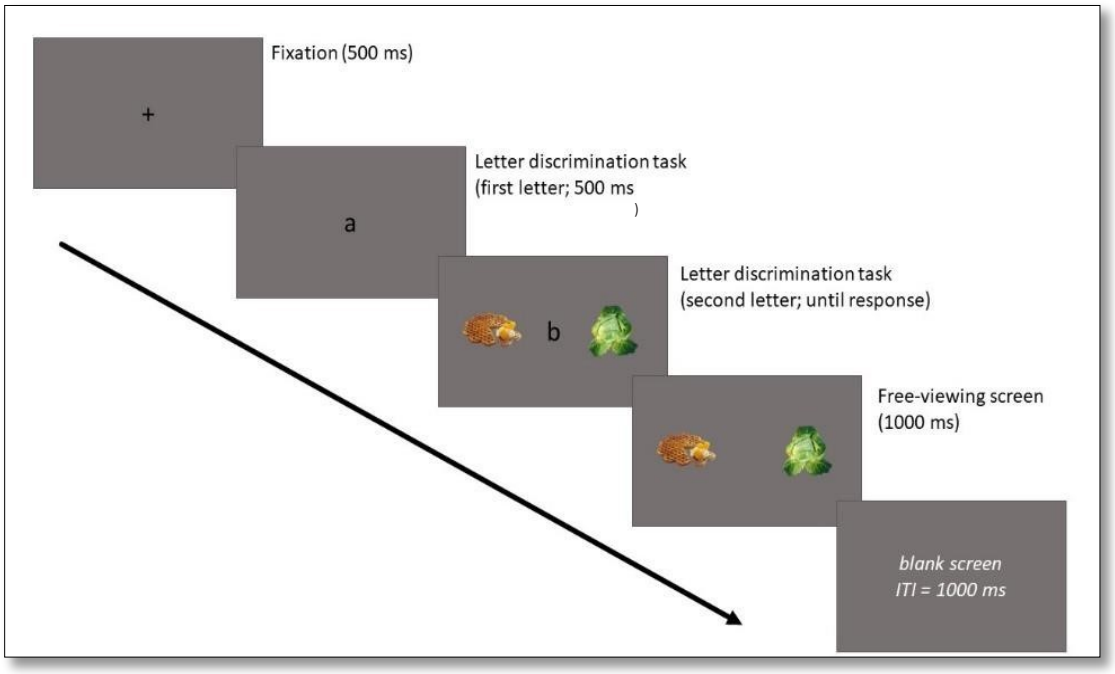


Figure 1 | Screen progression of each trial Four measures were analyzed:

Probability of First Fixation (PFF): The likelihood that the first fixation after the presentation of stimuli was directed towards a high- or low-calorie image.

Entry Time: The time taken to first enter the interest area containing the food image.

Dwell Time: The total duration of fixations within the interest area.

Fixation Count: The number of fixations within the interest area.

Data Analysis

Statistical analyses were conducted using R and JASP, to compare the orienting behaviour between high and normal BMI groups and within each group for high-calorie versus low-calorie food images. Paired ttests were used to assess differences in PFF, entry time, dwell time, and fixation count.

Results

Thirteen people who scored below 95% on the central letter discrimination task were removed from the analysis. We employed a 2 x 2 x 2 factorial design, where 2 groups of participants (overweight/obese BMI and normal BMI) were given 2 (Stimuli: High calorie and Low calorie) x 2 (Visual field: left and right). A repeated measures ANOVA was computed to analyse the effects of BMI and Stimuli type on eye movement measures. Results for all conditions have been computed.

Probability of First Fixation (PFF):

For PFF, the main effects of BMI, $F(1,9) = 1.152 * 10^{-13}$, $MSE = 1.887 * 10^{-31}$, $p = 1.000$, $\eta_p^2 = -1.280 * 10^{-14}$ did not reach significance, neither did main effects of stimuli type and

visual field. The interaction effect of stimuli type and BMI reached near significance with $F(1,9) = 4.446$, $MSE = 0.426$, $p = 0.064$, $\eta_p^2 = 0.331$. Further, upon doing a paired samples t-test, significant differences were found between the high BMI and normal BMI groups, with the high BMI group being more likely to first fixate on high-calorie images ($p = 0.029$). Within the high BMI group, significant differences were observed between PFF for high-calorie images in the right visual field versus the left visual field ($p = 0.048$), and between high-calorie images in the left visual field versus low-calorie images in the left visual field ($p = 0.012$). No significant differences were observed within the normal BMI group.

Entry Time:

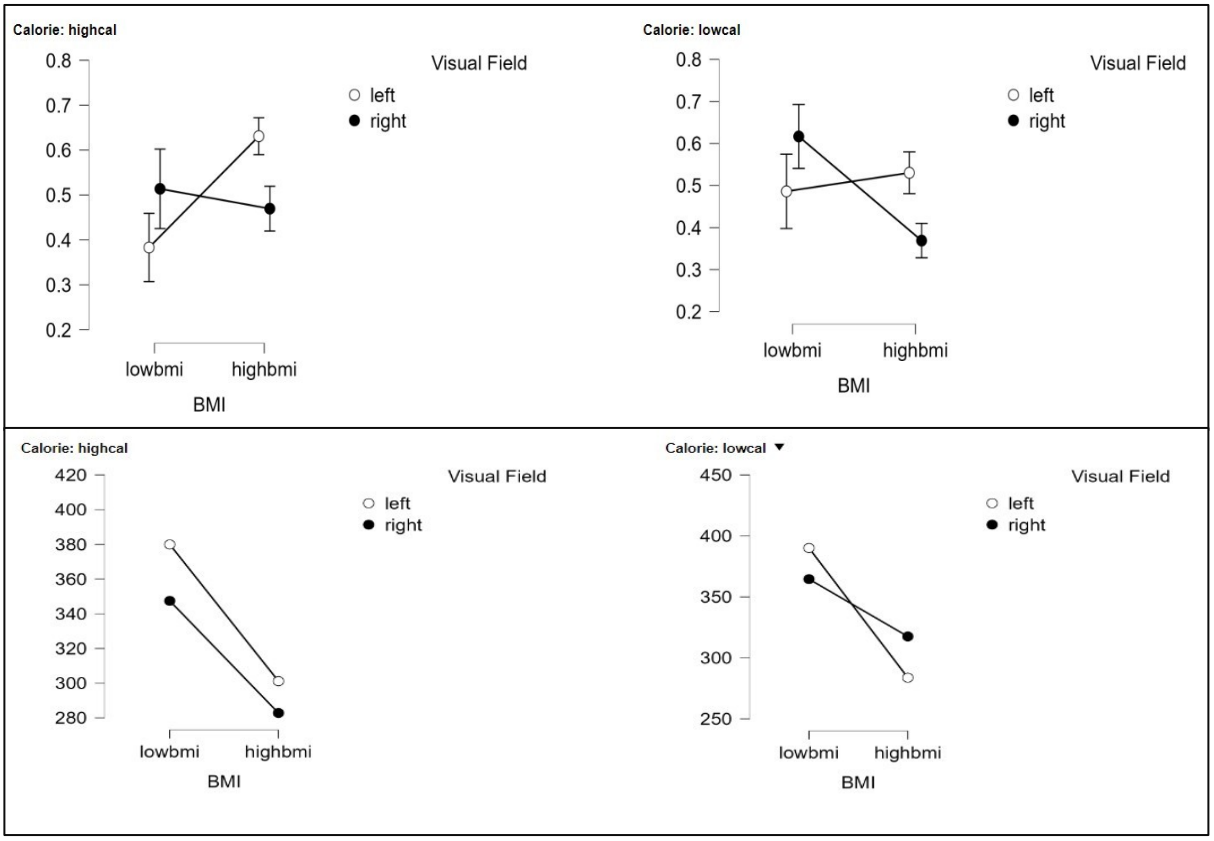
For entry time analysis, neither the effect of BMI nor stimuli type reach statistical significance ($F(1,9) = 0.617$, $MSE = 110071.875$, $p = 0.452$, $\eta_p^2 = 0.064$; $F(1,9) = 0.632$, $MSE = 2498.510$, $p = 0.447$, $\eta_p^2 = 0.066$). No significant differences were found in entry time between high and normal BMI groups ($p = 0.506$ for high-calorie images; $p = 0.643$ for low-calorie images). Within the normal BMI group, a significant effect of the visual field was observed for low-calorie images, with faster entry times for images in the right visual field compared to the left ($p = 0.043$ and $p = 0.046$ respectively). No significant withingroup differences were observed for the high BMI group.

Dwell Time:

For dwell time analysis, neither the effect of BMI nor stimuli type reached statistical significance ($F(1,9) = 0.324$, $MSE = 3560.656$, $p = 0.583$, $\eta_p^2 = 0.035$; $F(1,9) = 0.177$, $MSE = 429.575$, $p = 0.684$, $\eta_p^2 = 0.019$). Dwell time did not differ significantly between the BMI groups ($p = 0.983$ for high-calorie images; $p = 0.875$ for low-calorie images). However, within the high BMI group, there was a significant effect of the visual field on dwell time, with longer fixations on high-calorie images in the left visual field ($p = 0.021$) and low-calorie images in the right visual field ($p = 0.023$). No significant differences were observed in the normal BMI group.

Fixation Count:

For fixation count analysis, neither the effect of BMI nor stimuli type reached statistical significance ($F(1,9) = 0.654$, $MSE = 0.817$, $p = 0.440$, $\eta_p^2 = 0.068$; $F(1,9) = 0.303$, $MSE = 0.017$, $p = 0.596$, $\eta_p^2 = 0.033$). No significant differences were found in fixation count between or within the BMI groups, with p-values of 0.258 for high-calorie images and 0.322 for low-calorie images between groups. Within-group comparisons also did not reveal any significant effects.


Calorie: highcal
Visual Field
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Calorie: lowcal
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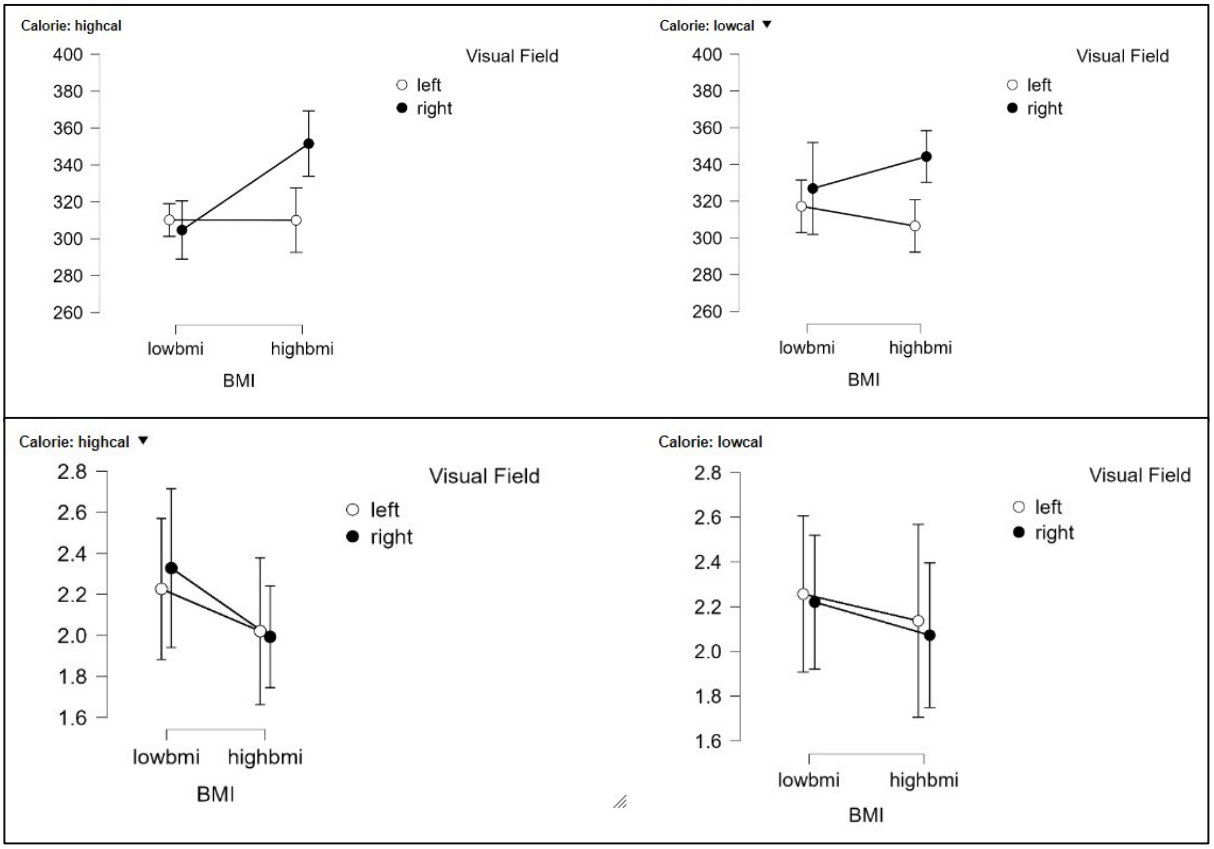
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Figure 2 | Values next to the horizontal lines represent mean scores of probability of first fixation, entry time, dwell time and fixation count compared between the two groups. Bars indicate standard errors.

Discussion

This study examined how individuals with different BMIs orient their attention towards high- and lowcalorie food images, with a particular focus on the influence of visual field presentation. The significant findings regarding PFF suggest that individuals with high BMI exhibit a bias towards high-calorie foods, especially when these images are presented in the right visual field. This finding supports the hypothesis that high-calorie foods, as high-value stimuli, are preferentially processed by the right hemisphere (Gupta et al., 2019).

In the present study, the higher probability of first fixation on high-calorie images in the right visual field among high BMI individuals could reflect this hemispheric preference. The lack of significant differences in dwell time and fixation count suggests that the initial orienting response, rather than sustained attention, is more sensitive to the value of the stimuli.

The absence of significant effects within the normal BMI group may indicate that the right-hemisphere bias for high-value stimuli is more pronounced in individuals with high BMI, potentially due to the increased salience of high-calorie foods for this group. Alternatively, the normal BMI group may have a more balanced processing of high- and low-calorie foods, leading to no clear preference.

Overall, these findings contribute to our understanding of how attentional biases towards high-calorie foods are modulated by BMI and suggest that interventions aimed at reducing these biases could be beneficial in managing unhealthy eating behaviours in individuals with higher BMI.

Conclusion

This study highlights the role of BMI in modulating attentional biases towards high-calorie foods, with a particular emphasis on the right-hemisphere bias for high-value stimuli. The findings provide insights into the cognitive mechanisms underlying these biases and offer potential avenues for interventions aimed at reducing the impact of such biases on eating behaviour.

Effect of Induced Empathy on Decoy Effect in Consumer Decision-Making Task

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Thapar School of Liberal Arts and Sciences

Introduction

The decoy effect is a well-studied cognitive bias in consumer decision-making wherein the introduction of an inferior option (a decoy) into the choice set can make one of the original but expensive options (the target) more attractive in comparison to the decoy or the other competitor option (Hu & Yu, 2014).

Empathy and decoy effect are found to share similar mechanisms. Previous researches have individually demonstrated that neural correlates of decoy effect (Hu & Yu, 2014) and empathy (Fan et al., 2011) are shared by virtue of activation of anterior insula in both these situations. However, no research so far has examined the combined effect of induced empathy over decoy effect. The current study aims to explore interaction between empathy and decoy effect. It is hypothesized that inducing empathy prior to a decoy task scenario will facilitate the decoy effect. Specifically, empathy will increase the participants' inclination to choose the 'target' instead of the 'competitor'. A deep understanding of this relationship could help marketers by providing them with a powerful tool to further enhance their decoy strategies by inculcating empathy inducing elements into their marketing campaigns.

The current study is part of a research work in progress and provides tentative data trend. Expected $N = 100$ in each group which will be presented in the conference. The current results are based on 20 pilot data collected (in each of the two groups) and the results assure the expected trend hypothesised in the research.

Methods

The current study uses a between-groups design and the participants are the students are Thapar Institute of Engineering & Technology, Patiala.

Participants are randomly assigned to one of these two groups: the experimental group, which had to first undergo an empathy induction task followed by performing the decoy task, and the control group, which only completed the decoy task.

To induce empathy, we carefully selected a Public Service Announcement (PSA): text-based message that has been proven to elicit a high level of empathy in prior researches (Shen, 2010). Additionally, State Empathy scale (SES) was used to measure the state empathy levels of participants in the experimental group. SES is a 12-item questionnaire used to assess participants' emotional responses on a 5-point Likert scale (Shen, 2010).

The decoy task (Dan Ariely, 2008) involved magazine subscription choices. In this task, the participants were presented with three subscription choices for a magazine: an online-only version, a print-only version, and a combination of both online and print. The currency was adjusted to suit the Indian context, thus ensuring both cultural and economic relevance.

The task specifically explored whether the experimental group chose target option more frequently under the influence of empathy in comparison to the control group. This was reflected in terms of participants choosing the print + online option (target) over the onlineonly option (competitor) in the presence of print-only option (the decoy; Sherlin et al., 2020).

Results

Data collection process for this study is currently ongoing and a pilot study has been conducted with the current sample size of approximately 20 participants (mean age: 20.45 yrs) in each group. Based on the preliminary analysis, we have drawn two primary results providing insight into the impact empathy has on the decoy effect.

Result 1: The comparison between the Control Group (which did not undergo empathy induction) and the Experimental Group (which did undergo empathy induction) supports the influence of empathy on the decoy effect. The frequency of the decoy effect was observed in 16.67% of participants in the control group and 45% in the experimental group. This difference clearly indicates that empathy induction may significantly enhance the decoy effect. However, the chi-square test results are not yet statistically significant results due to small sample size ($\chi^2 = 2$, $p = 0.157$).

Result 2: We further compared participants within the Experimental Group. We split them into High and low empathy sub-groups based on their empathy scores, and we observed that the frequency of the decoy effect differed significantly between the low empathy and high empathy subgroups. Decoy effect was found to be present in 33.3% of participants with low empathy scores (below the median) compared to 54.5% of participants with high empathy scores (above the median). Pearson's correlation analysis indicates a positive relationship between empathy scores and decoy effect frequency, with a correlation coefficient of $r=0.227$. While the current p-value of 0.168 does not yet indicate statistical significance, these preliminary findings still are encouraging.

As we continue to collect more data, we anticipate that the observed trend will become more robust, potentially reaching statistical significance and providing stronger evidence for the impact of empathy on the decoy effect.

Discussion

The preliminary results of this study support the proposed hypothesis that is relationship between empathy induction and the decoy effect. The observed trend that higher empathy levels are indeed associated with higher decoy effect frequency aligns with our hypothesis. Although these measures are not statistically significant in the initial analysis due to the limited sample size, the trends suggest that with a large sample size, the correlation will become stronger.

In conclusion, while the current results are promising and suggest a meaningful link between empathy and the decoy effect, more data points are needed to solidify these conclusions. This study has impactful implications for marketing strategies, particularly for marketers looking to leverage empathetic emotional engagement to influence consumer behavior through the decoy effect. Continued investigation would also contribute to a broader understanding of how cognitive biases can be modulated by emotional states such as empathy.

Exploring the relationship between switch cost, functional connectivity, and task complexity in a task switching paradigm using EEG

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Introduction

Human brain has the ability to perform multiple tasks together. This ability to multitask involves multiple brain areas to coordinate and work together. Task switching is a key component of cognitive flexibility, referring to the ability to transition between different cognitive tasks or activities. One of the ways to explore multitasking in a laboratory setting is through a task switching paradigm. Task-switching paradigms require participants to quickly transition between two or more distinct activities, with an advance cue usually indicating which task will be performed on the next trial. The response time (RT) difference between the switch and repeat trials when switching between two activities is described as the switch cost (switch cost = switch trial RT—repetition trial RT) (Yin et al. 2015). The present study utilizes the switch between rule sets during the paradigm between three blocksets. The present study also utilizes task complexity as a cognitive control condition during task switching.Cognitive flexibility is a fundamental aspect of human cognition, allowing individuals to adapt and switch between different tasks or mental processes swiftly. Task complexity is an essential factor in the study of cognitive flexibility. The level of task complexity affects how the brain allocates cognitive resources and, consequently, influences task-switching performance. Understanding the interaction between task complexity and cognitive flexibility can help in deciphering the neural underpinnings of human adaptability in diverse cognitive environments.The task complexity in present study is variable between blocksets and therefore an important instrument in understanding the role of cognitive control on switch costs.

Functional connectivity refers to the temporal correlation and coordination of neural activity between different brain regions. Investigating functional connectivity patterns in the context of task switching provides insights into how different brain regions cooperate and adapt during transitions between tasks.

Methods

The main objectives of this study were to compare reaction times between repeat and switch trials across different task conditions. We tried to analyze average functional connectivity during repeat and switch trials and investigate the relationship between switch cost and functional connectivity associated to switch cost between low complexity trials and high complexity trials. The task paradigm consisted of three different blocks with varying complexity for task switch and participants were asked to follow instructions to complete cognitive activities involving, two repeat trials with vowel consonant switch and uppercase lowercase switch, and one switch trial involving a switch between both these tasks.

For this study, Thirteen healthy participants from diverse backgrounds who have no history of neurological or psychiatric disorders were chosen through convenience sampling. The experimental strategy used in this study was intended to record EEG data signals during a task switching paradigm. A 3x1 within-subjects block design was used in the experiment constructed on SuperLab 6.0. The study utilized Electroencephalography alongside for neural data acquisition. We used an international 10-20 electrode placement system-based 32-channel EEG equipment. Seventeen electrodes out of the thirty-two channels were actively

employed to gather data. Accuracy and reaction times were among the behavioral data that were simultaneously gathered using SuperLab 6.0.

Results and Discussion

The behavioral analysis was done between the two repeat trials and one switch trial. The standard deviations suggested that the switch trials were the most challenging or variable, while the repeat trials between vowels and consonants were the most consistent. In general, a higher standard deviation indicated more variability in the reaction times, which suggested that the task was more challenging or that the participants were more inconsistent in their responses for 3rd block due to increased task complexity.

The analysis of behavioral data across three blocks for significant difference in reaction time through Friedman's test ($p = 0.00019$) strongly indicated that there was a significant difference among the three blocks RT. This meant that the cognitive processes involved in switch trials were different and more complex(Sakai, 2008). The average functional connectivity standard deviations for Blocks 1 (0.18), 2 (0.170), and 3 (0.173) were also very low. This consistency shows that the tasks could be performed consistently by the participants and that the experimental design was sound. The Friedman test for average functional connectivity across three blocks yielded a highly significant result which allowed us to reject the null hypothesis, indicating that there are indeed significant differences in average functional connectivity across the three blocks. For each individual, the graph indicated a general decline in functional connectivity throughout the course of the three blocks. This implied that the connectivity between various brain networks or areas weakened as the task advanced. Since the task set rules were more complex in Block 3, it might have contributed to variance in average functional connectivity. A complex pattern of interactions between the brain and behavior during task-switching paradigms was revealed by analyzing the correlation between switch cost and average functional connectivity over the three experimental blocks. There are no strong correlations between switch cost and average functional connectivity in any of the blocks. However, Block 3 shows a slightly stronger positive correlation compared to the other two blocks. Hence, owing to the small sample size, exploring the dynamics in Block 3 for different frequency bands can be a direction towards further development of the study to understand the neural dynamics between functional connectivity and switch costs.

Keywords: Task switching, Task complexity, Functional connectivity, EEG, Switch cost

Varied interlocutors' language proficiency alters cross-linguistic activation in bilinguals:

Evidence from eye movements

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Introduction

The bilingual mind is a remarkable example of human cultural evolution's adaptive strategies to forge social relationships. This is manifested by the bilingual's intuitive ability to guess the languages of potential interlocutors in specific contexts and modulate cognitive control depending on contextual needs (Rafeek & Mishra, 2021). Bilinguals activate multiple languages unconsciously when presented with one in any modality. This has been long hailed as the most significant aspect of the bilingual users' psycholinguistic mental model. Activating context-irrelevant languages is also problematic when we think of the mind as a system that has evolved to suspend all such distractions and employ its resources on what is relevant. In the following experiments, we examine the hypothesis that bilinguals unconsciously activate the perceived dominant language of the interlocutors in two visual world eye-tracking experiments.

Methods and prediction

The study used the visual-world paradigm to examine whether previously familiarized high and low-L2 proficient interlocutors influence cross-linguistic activation during spoken-word recognition in bilinguals. Experiment 1 was done to replicate the findings of Singh and Mishra (2015) and Kapiley and Mishra (2018). During the experiment, the spoken word is accompanied by four line-drawn objects: one object is the target, one phonological translation equivalent of the target (TE cohort), and the other two are distractors/ unrelated words. These objects are not semantically related. We predicted that participants with high L2 proficiency would demonstrate cross-linguistic activation when the spoken word is in L1. In experiment 2, we presented an interlocutor (high, low L2 proficient, and neutral interlocutors) before the visual world task. We hypothesized that the awareness of interlocutor L2 proficiency would alter the degree of cross-linguistic activation in L2-proficient bilinguals. BLINCS model for spoken word recognition (Shook & Marian, 2013) assumes that bilinguals have a shared phonological system and lexical level, a distinct but integrated system, and cross-linguistic activation occurs at the phonological and lexical levels. Further, the model predicts that the auditory and visual systems affect the phono-lexical level. However, spoken word recognition and production theories vary in their mechanisms. We predicted that participants would show cross-linguistic activation when the spoken word is in L1 with a high L2 proficient interlocutor. Meanwhile, in the presence of low L2 proficient interlocutors, they would show cross-linguistic activation when the spoken word is in L2.

Results and discussion

Our data suggest that the participants were sensitive to the presence of interlocutors. Experiment one data indicates cross-linguistic activation around 400 – 600 ms when the spoken word was in L1. The proportion of fixations to the TE cohort in L2 was higher than the distractors in that time window. Whereas when the spoken word was in L2, there was no evidence of such cross-linguistic activation. The main experiment results revealed that the interlocutors associated with two languages but varied proficiencies modulated the target activation. Upon seeing the high and low L2 proficient interlocutors, participants activated both languages as indicated by the higher proportion of looks to the target in the third time

window (600 – 800 ms). When participants saw the neutral interlocutor, the proportion of looks to the target was significantly lower. During the familiarization phase, the participants heard audiovisual interlocutors, enabling them to associate languages with the interlocutors. The faster and higher target activation in the presence of high and low proficient interlocutors indicates that the participants associated both languages with the interlocutors irrespective of their language proficiencies.

Interestingly, in neutral interlocutor presence, the target activation was slower during the third time window (600 – 800 ms). It could be so that the participants did not associate any language with the neutral interlocutors as they were unaware of their language proficiencies. However, there was higher target activation when the spoken word was presented in L2 in the presence of a neutral interlocutor; this can be attributed to the participants; language proficiency. Time-course analysis revealed the translational equivalent (TE) cohort activation in L2 (400ms - 600ms) in the presence of a high-L2 proficient interlocutor, specifically when the spoken word was in L1 and TE activation of L1 (400ms - 600ms) during L2 spoken word in the presence of a low l2 proficient interlocutor. This indicates that the perceived L2 proficiency of the interlocutors modulates cross-linguistic activation during bilingual audiovisual language processing. In this study, the participants were high L2 proficient, and the activation of L2 would be relatively higher than L1 because of their higher usage and exposure to L2, as indicated by both self-report and objective language control measures.

Efficacy of regulation focused psychotherapy in managing externalizing behavioural problems among children and adolescents: A psychophysiological study

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Introduction

Externalizing disorders are the third most common mental health issue in children and adolescents (World Mental Health Survey, 2018), including problems like poor impulse control, attention issues, aggression, rule violations, and substance abuse (DSM-5). Early detection is crucial to prevent future violence (Betz, 1995).

Cognitive Behavioural Therapy (CBT) has shown effectiveness, but its impact on daily life is not fully understood (Riise et al., 2021). Parental training is often combined with CBT due to the difficulties of working with children alone (Lochman et al., 2008). Furthermore, CBT may not adequately address implicit emotion regulation, essential for managing these behaviours (Cavanagh et al., 2017).

Our study utilized Regulation-Focused Psychotherapy for Children (RFP-C), an integrative approach blending behavioural and psychodynamic techniques to address emotion regulation and moral development deficits. We also used ERP (Event-Related Potentials) to assess changes in inhibitory control in response to facial emotions using the odd-ball paradigm (go/no-go trials) in children with externalizing disorders.

Methods

A hospital-based study recruited 37 children and adolescents aged 7-17 (Mean = 14.40 years, SD = 2.91) with externalizing behaviours, as identified by the Child Behaviour Checklist (CBCL) and diagnosed with ICD-10 DCR 1993. Participants were chosen from an outpatient setting through purposive sampling. Inclusion and exclusion criteria of age, intelligence, etc. were assessed and then twenty were randomly assigned to the two groups of experimental and treatment-as-usual (TAU). T-tests (on the child's age, CBCL externalizing and DAST scores) and Fischer's exact analyses of socio-demographic variables (education religion, habitat, and socio-economic status) revealed no group difference.

Baseline assessments used the Family, Peers, and Externalizing Behaviour in Adolescence (FPEB) scale, the Difficulties in Emotion Regulation Scale (DERS), and the Moral Identity Questionnaire (MIQ) to evaluate relationships, emotion regulation, and moral development. The experimental group received Regulation-Focused Psychotherapy for Children (RFP-C) with pharmacological intervention, while the TAU group received CBT/BT with pharmacological intervention.

ERP data on response inhibition was collected using EB Neuro prewired head caps with 128 channels, employing an oddball paradigm (80% Go cues, 20% No-Go cues) to measure inhibitory control (figure 1&2).

Results

Independent samples t-test compared continuous variables like age. A 2 (time point) × 2 (group) repeated measures ANOVA assessed change in outcome measures including CBCL, DAST, FPEB, DERS, MIQ scales, and N200 ERP values.

For externalizing behavioural problems measured by the Child Behavior Checklist (CBCL), the experimental group (M=31.30, SD=21.32) and the TAU group (M=48.00, SD=14.97)

showed higher values (F-value, p=0.001) as illustrated in Graph 1. For externalizing behaviour in family and peer contexts as measured by the FPEB, the experimental group (M=61.80, SD=5.39) and TAU group (M=71.40, SD=7.57) the former scored higher showing more symptoms in the experimental group (p=0.002), as shown in Graph 2.

The experimental group demonstrated significant improvement in emotion regulation (DERS: M=19.70, SD=5.44, p=0.003) and moral development (MIQ: M=28.00, SD=2.40, p=0.001) compared to the TAU group, as indicated in Graphs 3 and 4 respectively. Regarding the N200 ERP measure during the No-Go subtask, the experimental group (M=3.93, SD=3.05) showed significant improvement in amplitude and latency of N200 as compared with TAU group (M=1.33, SD=1.45) (p=0.020), as shown in Graph 5.

Discussion

The study indicates that Regulation-Focused Psychotherapy for Children (RFP-C) was three times more effective than treatment-as-usual (TAU) in reducing emotion regulation difficulties. RFP-C addresses implicit emotional regulation deficits, enhancing self-esteem and self-mastery by increasing emotional awareness and tackling defenses such as denial and projection, alongside externalizing behaviour issues (Prout et al., 2015; Hoffman et al., 2015).

Improved emotion awareness and regulation are vital for moral development (Eisenberg, 2000). This study found that gains in moral development were linked to better emotion regulation. The reduced N200 amplitude (200-350 ms post-No-Go stimulus) in the right temporal region indicates less effort in inhibitory control under stress (Woltering et al., 2013), aligning with Bunge et al. (2002) who noted that inhibition is associated with posterior brain areas rather than prefrontal ones.

Regulation-Focused Psychotherapy for Children (RFP-C) effectively enhances externalizing behaviour, emotion regulation, and moral development, with notable changes in electrophysiological functioning. RFP-C is presented as a cost-effective treatment for externalizing disorders in children and adolescents.

Keywords: Externalizing behavioural problems, ERP, Regulation Focused Psychotherapy, Children and Adolescents.

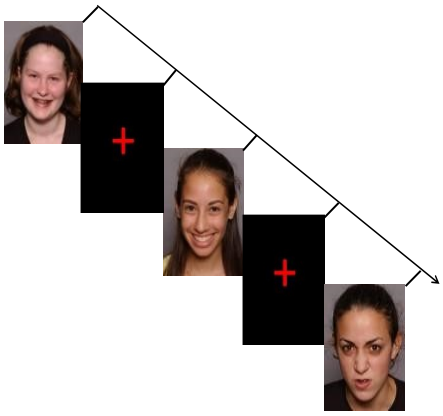


Figure 1: *An example of the schematic illustrating three trials of the go/no go task in which happy faces served as go cues and all other faces served as no go cues. Face images are from the Emotion Face Dot Probe Task (Bradley et al.,1998).*

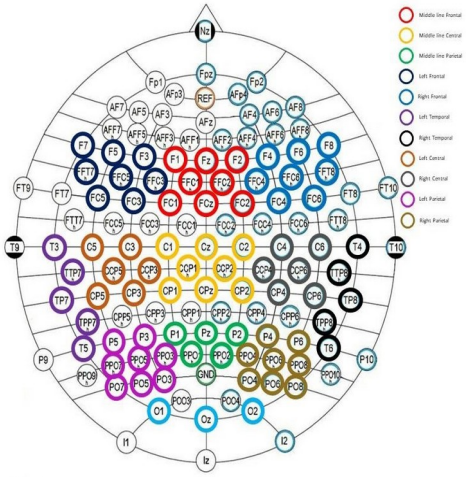
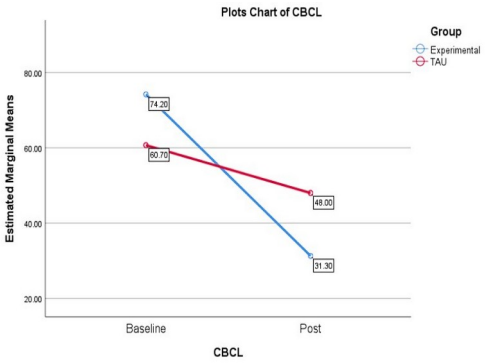
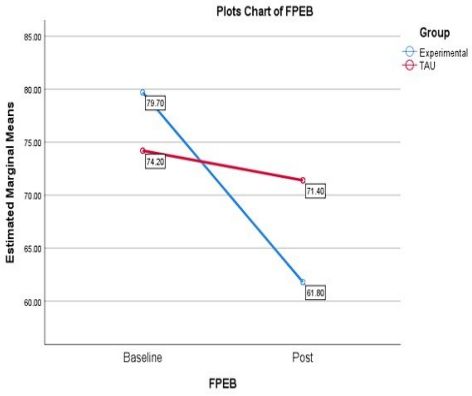


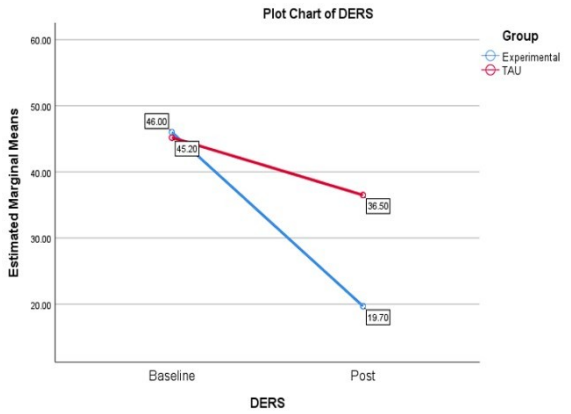
Figure 2: *Eleven clusters e regions of indicat interest.*



Graph 1: *Indicating the difference in the CBCL score across time between the*



Graph 2: *Indicating the difference in the FPEB score across time between the*



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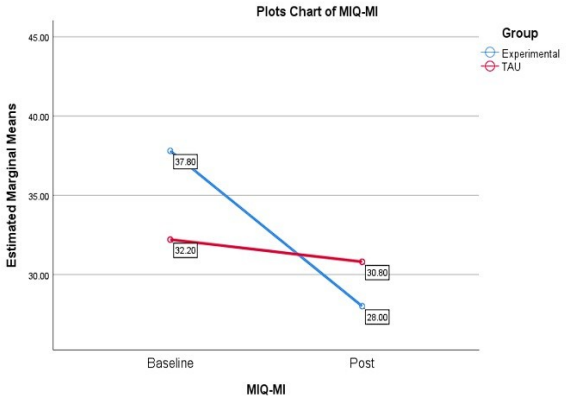
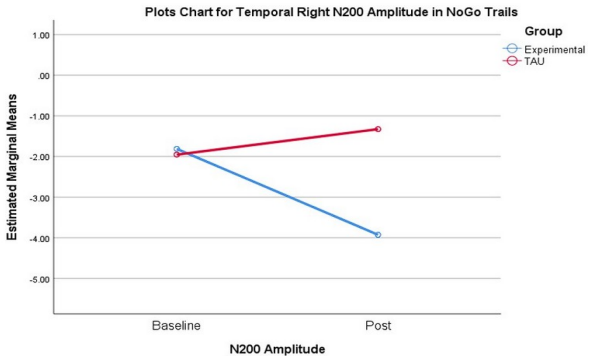
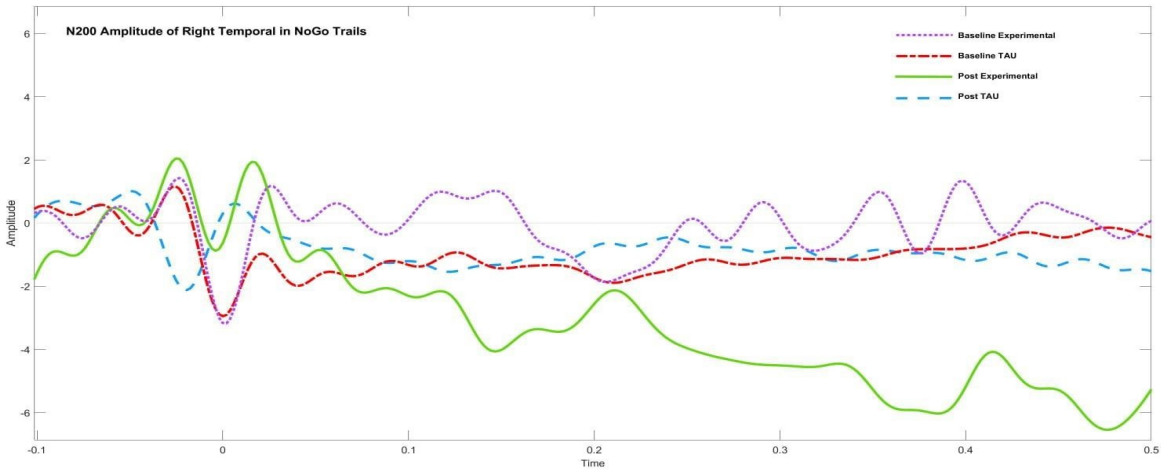
Graph 3: *Indicating the difference in the DERS score across time between the*



Graph 4: *Indicating the difference in the MIQ_MI score across time between the*



/***Graph 5:*** *Indicating the difference in the temporal right region post-treatment in comparison between the Experimental and TAU groups (N=20)*



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Role of Loneliness on Attentional Bias and Social Working Memory in Young Adults

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Introduction

Loneliness is a critical psychosocial challenge linked to psychopathologies ranging from Depression to Alzheimer's disease (Hossain et al., 2020). The study aims to understand how loneliness can affect socio-cognitive processes like attentional bias and social working memory (SWM). The key characteristic of individuals who are lonely is their attentional bias towards social stimuli such as faces. Individuals who are lonely, as compared to those who aren't, react faster to faces of negative emotions than neutral compared to individuals who are not lonely (Du et al., 2022).

Loneliness is a common risk factor for anxiety and depression (Steen et al., 2022). Anxious individuals tend to focus on external negative cues, while those with depression engage with self-relevant stimuli (Mogg & Bradley, 2005). However, individuals low and high in loneliness are biased towards positive pictures and negative pictures of social stimuli, respectively, as compared to objects (Cacioppo et al., 2009).

Attentional bias enhances the capacity of working memory (WM) by suppressing the processing of distractors (Ahmed & De Fockert, 2012; Ku, 2018). SWM, a type of WM, is a relatively new concept defined as the specialised process of storing, maintaining and manipulating social stimuli such as faces, emotions, people's traits and mental states (Meyer & Lieberman, 2012; Meyer et al., 2015; Vogel, 2016). Distinguishing attentional bias processes can clarify how loneliness affects social working memory (SWM). This is an ongoing research, aiming to explore the impact of loneliness on SWM and attentional bias towards emotional stimuli, offering theoretical insights into the socio-cognitive processes in young adults who are lonely.

Methods

The study was conducted in two phases. In Phase 1, informed consent, demographic data, and questionnaire responses were collected via Google Forms. The UCLA Loneliness Scale (Version 3) measured loneliness, while the DASS-21 screened for low-moderate depression and anxiety (Mogg & Bradley, 2005). 53 individuals participated (M = 12, F = 41). After the screening, 31 right-handed participants (M = 6, F = 25, aged 18-25, M = 20.61, SD = 1.56) were selected for Phase 2, which involved a social-cognitive task on CHRIST University's Bengaluru campus with departmental ethical approval.

Participants completed the AB-SWM task, combining the SWM paradigm (Vogel, 2016) and a modified dot-probe task for attentional bias (Wei et al., 2020). The task involved displaying two faces, with an attentional bias task in between. In the SWM component, participants compared facial features, age, and gaze, responding within 600 ms per trial. In the attentional bias component of the task, social scenes were presented on either side of the fixation cross. A single trial, therefore, will take 1200 ms, including reaction time (RT). After 12 practice trials, 36 main trials followed, with 12 trials per condition (face, age, gaze).

Data was cleaned, and RT for attentional bias and accuracy scores for SWM were derived from the task. Attentional bias trials with RTs > mean + 3SD were excluded. Only trials with correct responses to both questions were included for the SWM task. One participant was excluded due to low accuracy (61%) in the attentional bias task.

Results

Participants had a loneliness score of M= 40 (SD = 8.84). The attentional bias task showed an accuracy of 94% (SD = 6.96) with RT averaging 543 ms (SD = 102.19 ms). The

SWM component had an overall accuracy of 72.40% (SD = 9.8%), which is consistent with Vogel's (2016) SWM task. Accuracy was highest for gaze-related questions (M = 84.16%, SD = 13.85%), followed by age-related (M = 71.89%, SD = 15.87%) and facial features (M = 61.68%, SD = 16.12%). Spearman's correlation analysis revealed a moderately negative relationship between loneliness and accuracy in facial feature-related questions (ρ = -0.442, p < .05). Further analysis is needed to test the hypothesis, which we aim to complete before the conference.

Discussion

The study's SWM accuracy aligns with Vogel (2016), suggesting that lonely individuals can still manipulate social cues. However, unlike Vogel's findings, participants in this study found gaze-related questions easier than full-face questions, indicating that gaze cues may be simpler to store (Nie et al., 2018). While loneliness has been linked to sensitivity to emotional cues (Vanhalst et al., 2017), this study suggests that increased loneliness may reduce accuracy in remembering facial features. Further analysis is needed to explore attentional bias nuances**.**

Investigating Hippocampal Long Axis Specialization with High-Resolution 7T fMRI

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Introduction

The hippocampus has been a widely studied subcortical area that plays a crucial role in long-term memory (1). Research has shown that the hippocampus shows internal variability in its structure and function as well as distinct patterns of functional connectivity along the long axis (2-3). Evidence from human and animal studies has shown a functional specialization along the long axis of the hippocampus (4-5).

One of these important functional specializations is the encoding-retrieval dimension. Evidence has shown that the anterior hippocampus (aHPC) is specialized for encoding while the posterior hippocampus (pHPC) is specialized for retrieval (6).

However many studies don't fit this pattern or have been criticized for having design confounds, low statistical power, or precision (4). To address this gap, we used a high-precision 7T fMRI dataset where the participants performed a continuous recognition task across tens of thousands of images presented over a long time (7).

Methods

For the study, we utilized the Natural Scenes Dataset (NSD) (7). Each participant was shown 10,000 distinct images which were repeated twice. Each run was 5 minutes long and consisted of 62-63 stimulus presentations with a total of 12 runs (750 trials) within a scan session. The participants (n=8) performed a continuous recognition task and were instructed to respond to the question "Have you seen this image before?". The dataset consists of high-resolution functional MRI data collected at 7T with 1.8-mm resolution for about 40 scan sessions across a year. The upsampled 1-mm subject native space version of the data was used for the analysis. General Linear Model (GLM) analysis was performed to obtain beta coefficients for each voxel followed by GLMdenoise for denoising and ridge regression to improve the estimation of the betas. The estimated beta files are publicly available from the NSD dataset.

An individualized atlas was generated using hippocampal segmentation from the Freesurfer aseg pipeline by manually annotating anterior and posterior ROIs using uncal apex as the landmark (4). All voxels in the Freesurfer segmented hippocampus posterior to the uncal apex were assigned to posterior ROI and the ones anterior were assigned to anterior ROI.

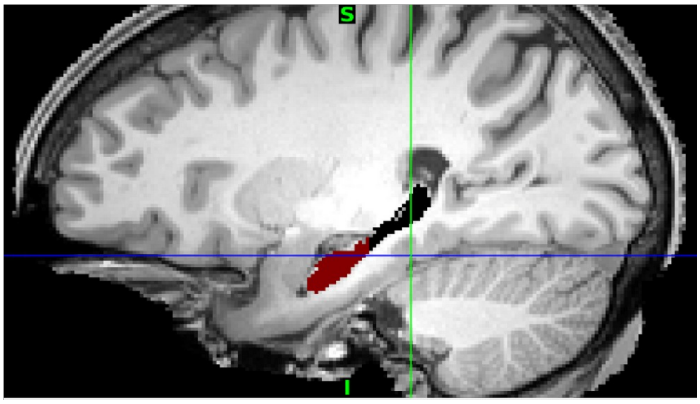

Figure 1: Image overlay of individual specific atlas overlaid on T1 Space. Red represents aHPC and black represents pHPC.

The activation levels for the anterior and posterior Hippocampus were extracted for faces, scenes, objects, animals, and food. The categorization was obtained from the COCO dataset for objects, animals, and food while for faces and scenes, the manual categorization was used. The data was further filtered to include only valid responses which were defined as when the stimuli was correctly recognised as old or new. The activation values were compared across the long axis of the hippocampus for all the categories. For faces and scenes, the activation values were further separated into first, second, and third presentations.

Betas for each region were averaged for each trial. Repeated measures ANOVA was used to compare the activation levels for presentation (first, second, third) for aHPC and pHPC across various categories (face, scene, object, food, animal) resulting in a 5x3x2 model.

Results

Statistical analysis revealed a strong effect for the HPC (anterior, posterior) and presentation time interaction ($F(2, 258) = 23.458$, $p<0.001$, partial eta-square = 0.154). After performing Tukey's post-hoc test, it was observed that the aHPC was significantly more active while the stimulus was being presented for the first time (encoding), but the aHPC showed significant deactivation for retrieval stages. pHPC was less active during the first presentation but showed significantly more activation in the second and third presentations. There were no significant differences in the second and third presentations. We did not find any strong effect for categories as the activation pattern of encoding-retrieval dichotomy was preserved over all the categories.

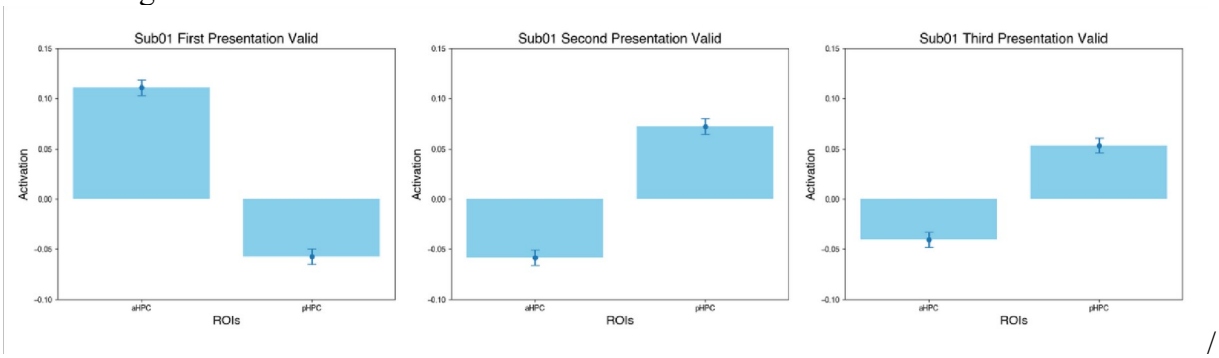

Figure 2: Activation (percent signal change) across stimuli presentations (first, second, and third) for aHPC and pHPC.

Discussion

These results further support the encoding-retrieval functional specialization along the long axis of the hippocampus. The deeply sampled dataset collected across a long time scale (around one year) gives additional credence to the encoding-retrieval hypothesis which was missing in prior studies. The activation in the hippocampal regions did not differentiate across stimuli from different categories highlighting the stimuli-invariant process of encoding and retrieval of memories.

Interactions between the cortex and hippocampus are considered crucial for episodic and declarative memory processes (8). Functional connectivity studies along the long axis have shown that DMN is coupled with the hippocampus during retrieval and decoupled during encoding (9). As DMN deactivates in goal-oriented processing (3), the deactivation of aHPC can be putatively explained using these findings. The activation of pHPC can be also understood as the result of its functional connectivity with the Parietal Memory Network (PMN) as it is known to be active during the retrieval stage (10). Further research needs to quantify these cortical hippocampal interactions and how encoding and retrieval processes act in conjunction with large-scale distributed networks like DMN and PMN.

Late sight-onset and its influence on visual search

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Introduction

Visual search or the ability to locate and identify an object of interest amidst many distractors, is a critical cognitive ability. Humans rely heavily on their visual search skills to distinguish a specific item from a group of other items based on their visual characteristics (Treisman & Gelade, 1980). In certain professions, like medicine and security, having good visual search skills is a necessity.

Since this process requires a high level of vigilance to identify objects amidst many distractors, attention plays a crucial role in visual search (Arguin et al., 1993; Müller & Krummenacher, 2006). Guided Search Theory (Wolfe et al., 1989) proposes that the search process is dynamic and influenced by both bottom-up and top-down factors. Similarly, there are many stimulus-dependent factors such as distractor orientation, distractor number, target eccentricity, etc., that are known to affect the search process.

The present study attempts to investigate how this ability develops and the factors involved. Specifically, we probe whether early visual experience is critical for the development of visual search ability. For this, we examined a unique group of children who were born blind and whose sight was surgically restored years later. Previous work with late-sighted individuals has shown that while visual proficiencies such as categorical face perception, visual memory capacity, and cross-modal mappings (Gandhi et al., 2017; P. Gupta et al., 2022; Held et al., 2011) can be acquired later in life, post-surgical limitations in areas such as basic visual acuity, shape recognition, configural face judgments, or generalization to color removal remain (McKyton et al., 2015; Piller et al., 2023; Vogelsang et al., 2024). It is unknown whether and how visual search ability is impacted by early-onset and prolonged visual deprivation.

Methods

The study used a visual search task called homogenous pre-attentive pop-out. Participants were instructed to "Point to the bar that looks different from others". The target bar was oriented at a 60° angle while distractors were oriented at six different angles (15, 30, 45, -15, -30, -45) divided into three sets of different numbers of distractors (5, 10, 15). A total of 9 patients participated in this task at different time points after surgery. 9 age-matched and acuity-matched controls also participated.

Results

A difference-indifference analysis between response time (RT) of control population and other three major patient data collection time points reveal that control group is significantly faster than the late-sighted group before-surgery, immediately-after-surgery, and after-more-than-a-year. Before-surgery and immediately-after-surgery are indifferent, but after-more-than-a-year is faster than before-surgery.

Discussion

These results indicate a gradual improvement in the visual search ability over time in this special population of sight-restored children. Evidence of the acquisition of this ability even after several years of blindness, points to significant plasticity in the neural infrastructure supporting the visual search process. The next phase of this research will involve computational modeling of the data to better understand the factors contributing to this gradual increase in visual search capacities, what it entails, and how it can be potentially improved. Similar to past works in computational modeling of the search process (Gupta et al., 2021), we are pursuing deep CNN models such as eccNet to modify the parameters based on our task features and compute model performance on the task to compare with control group performance. The next step would be to compare model performance with patients' performance. This would allow a deeper observation of mechanisms and factors involved in the visual attention and search processes of the special population.

Reconstruction of Drumbeat Music from EEG Data

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Introduction

Music is an universally core part of our cognitive lives.(Peretz 2006).Recent advances in deep learning have enabled new methods for decoding brain signals to reconstruct sensory experiences like vision and hearing (Large et al 2015). This study aims to reconstruct auditory stimuli from EEG data using a combination of convolutional neural networks (CNNs) and long short-term memory (LSTM) networks, capturing both spatial and temporal features of the brain's electrical
activity.

Previous research has demonstrated that EEG signals contain information about auditory perception(Harding et al 2019). However, reconstructing complex stimuli such as music or speech from EEG data remains challenging (Bellier et al., 2023). This study's primary objective is to develop and evaluate a deep learning model that reconstructs audio signals from EEG data recorded while participants listen to a 30-second audio clip of drum beats. Two approaches are compared: using preprocessed ICA-cleaned EEG data and raw EEG data without any preprocessing. The performance of these approaches is evaluated based on the accuracy and quality of the reconstructed audio.

Method

Participants and Data Collection

Seventeen participants aged 18 to 35, all with normal hearing and no neurological disorders, participated in the study. EEG recordings were collected while participants listened to a 30-second audio clip of drum beats, recorded at a sampling rate of 1000 Hz using a 64-channel EEG system. Event markers were placed at the beginning (`AUDBEG`) and end (`AUDEND`) of each audio clip to segment the EEG data into epochs.

Data Preprocessing

EEG data were preprocessed to remove artefacts such as eye blinks, muscle movements, and electrical noise. Independent Component Analysis (ICA) was used to identify and remove these artefacts. The cleaned EEG signals were then segmented into 1-second epochs to capture dynamic brain responses more effectively. The corresponding audio clip was also divided into 1-second segments, creating a dataset for training the model. To evaluate preprocessing's impact, raw EEG data were also analysed without any preprocessing.

Neural Network Architecture:

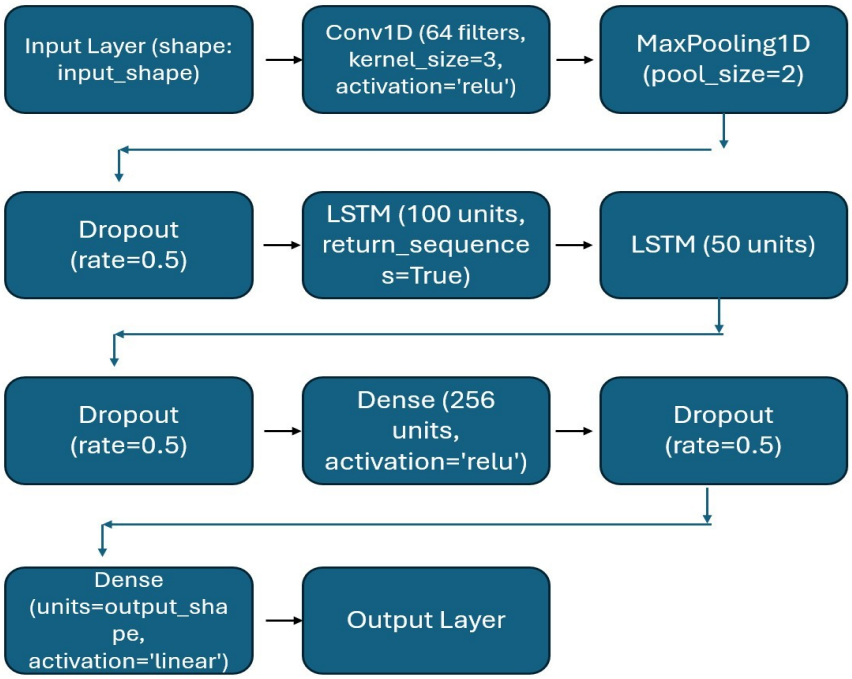
The model consisted of convolutional and recurrent layers:

Convolutional Layers: A 1D convolutional layer with 64 filters and a kernel size of 3 was used to extract spatial patterns from the EEG data, followed by a max-pooling layer to reduce dimensionality.

Long-Short-term-memory (LSTM) Layers: Two LSTM layers modelled temporal dependencies: the first with 100 units (returning sequences) and the second with 50 units (not returning sequences).

Fully Connected Layers**:** Dense layers with 256 units and a linear output layer mapped the EEG data to the corresponding audio signal.

The model was compiled using the Adam optimizer and mean squared error (MSE) as the loss function, with early stopping implemented to prevent overfitting.



Model Training and Evaluation

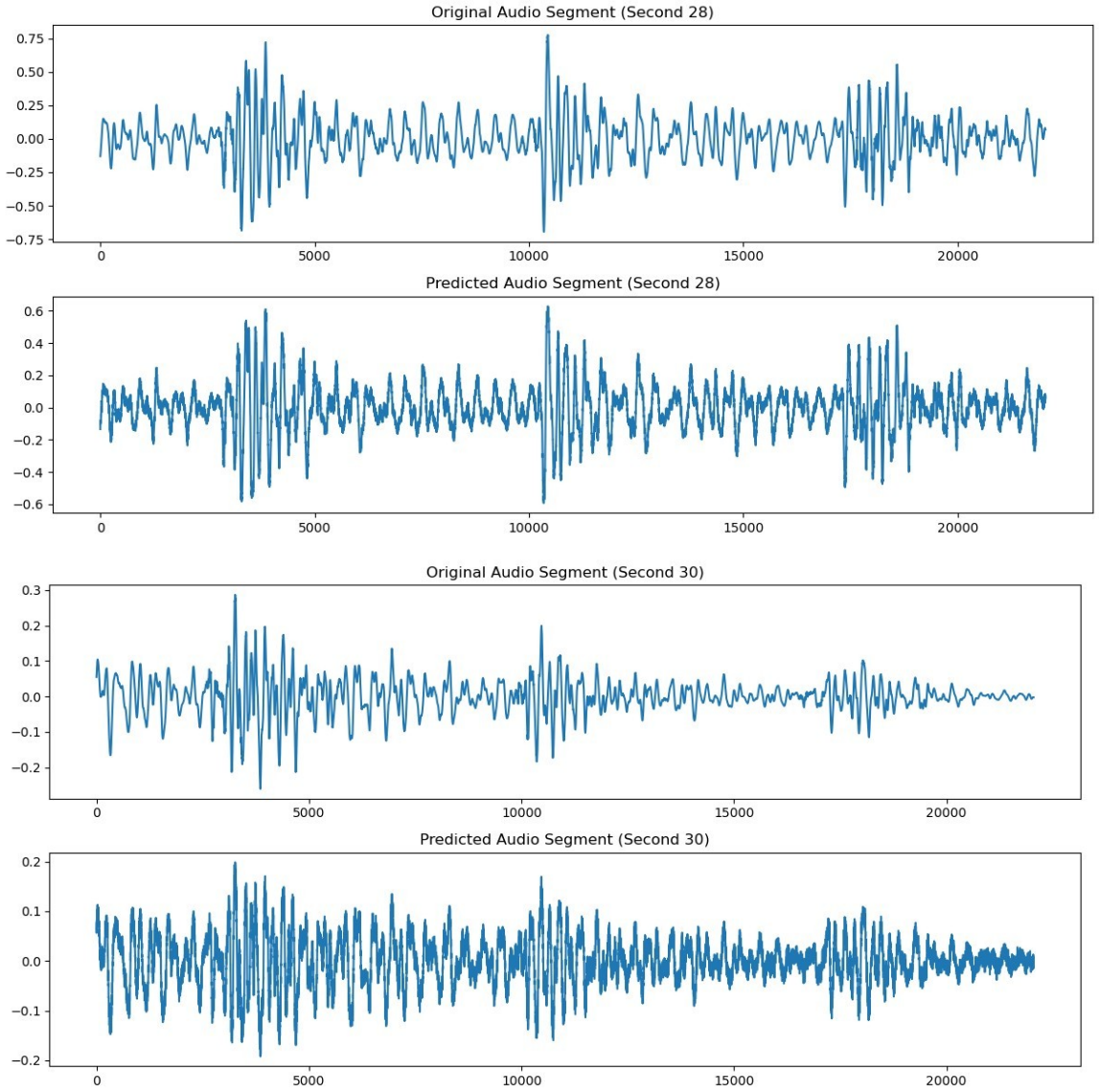
The model was trained using a sliding window approach, where each 1-second EEG epoch was paired with its corresponding 1-second audio segment. The training process involved iterating through a directory of audio files, matching EEG epochs to corresponding audio events (`AUDBEG` and `AUDEND`), and reconstructing the audio signal from the EEG data. Two datasets were used: one with preprocessed EEG data and another with raw EEG data. The models' performance was evaluated using the MSE between the predicted and original audio segments. The reconstructed audio segments were then stitched together to recreate the entire 30-second audio clip.

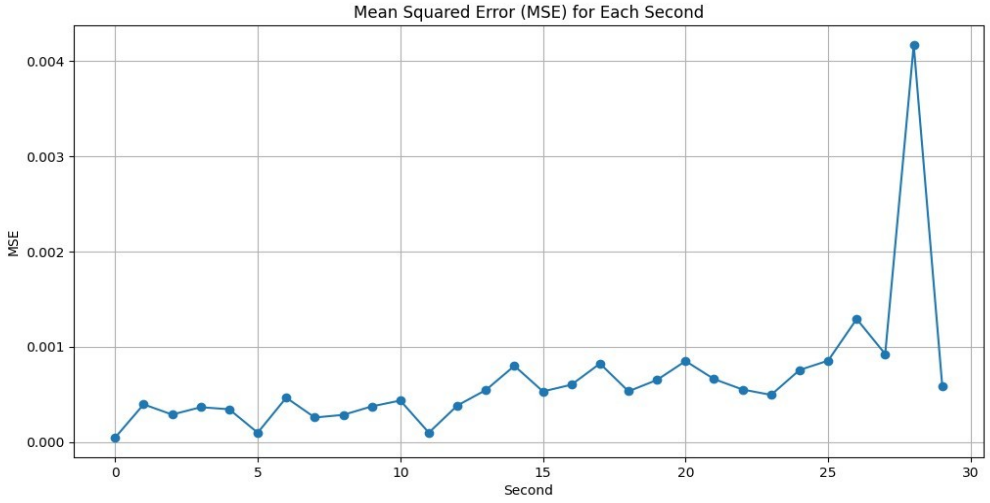
Results

The study showed that the neural network model could reconstruct audio signals from EEG data with high fidelity. For preprocessed EEG data, the MSE between predicted and original audio segments was relatively low, and the reconstructed audio clips retained key characteristics like rhythm and pitch.

In contrast, raw EEG data (without preprocessing) produced reconstructions with higher MSE scores. However, the audio reconstructed from raw EEG data was subjectively clearer, though slightly muted, compared to that from preprocessed EEG data. This suggests that raw EEG signals may retain more information relevant to the auditory experience, which could be lost during preprocessing steps like ICA.

Given below are the evaluation plots for ICA cleaned Data





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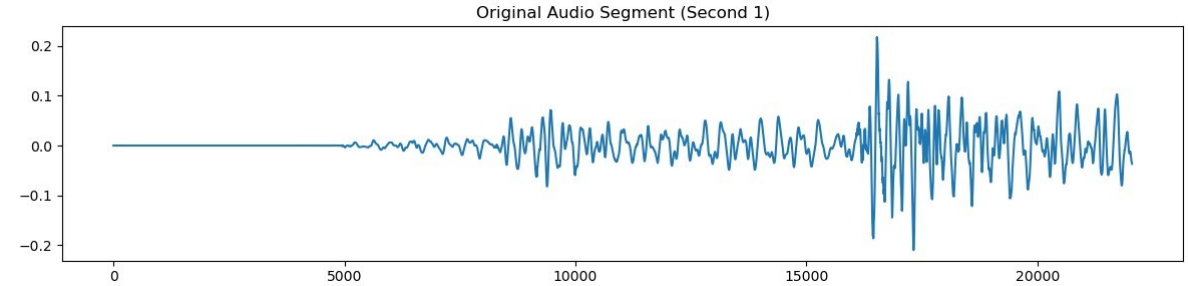
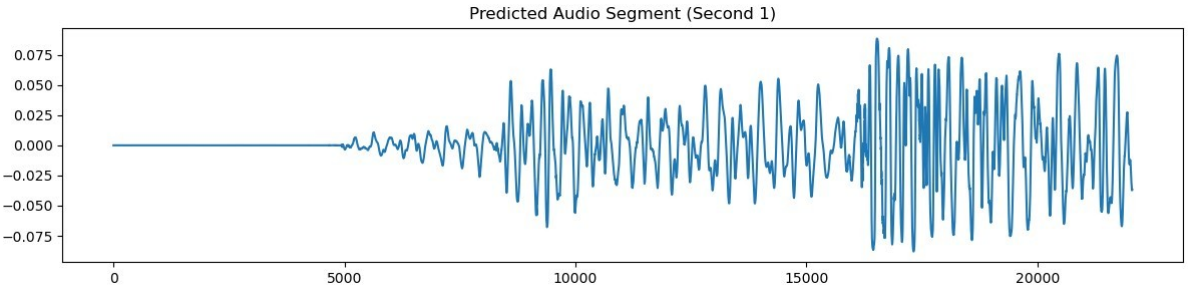
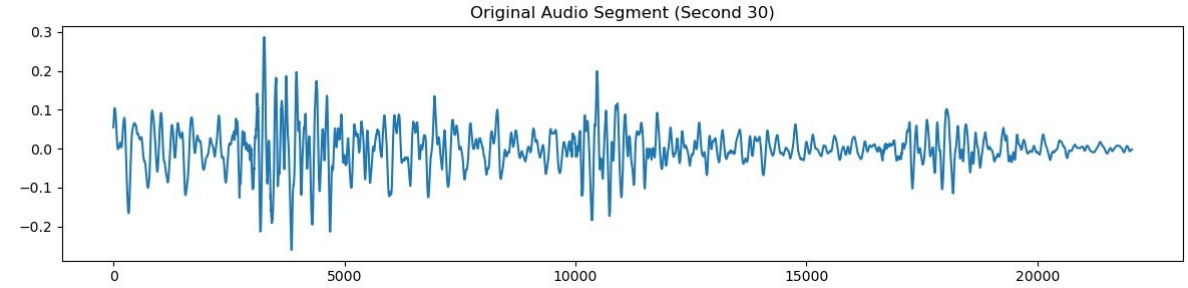
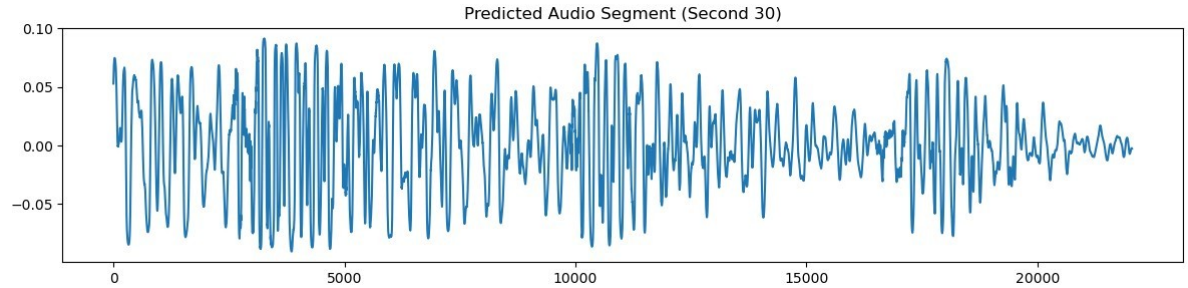
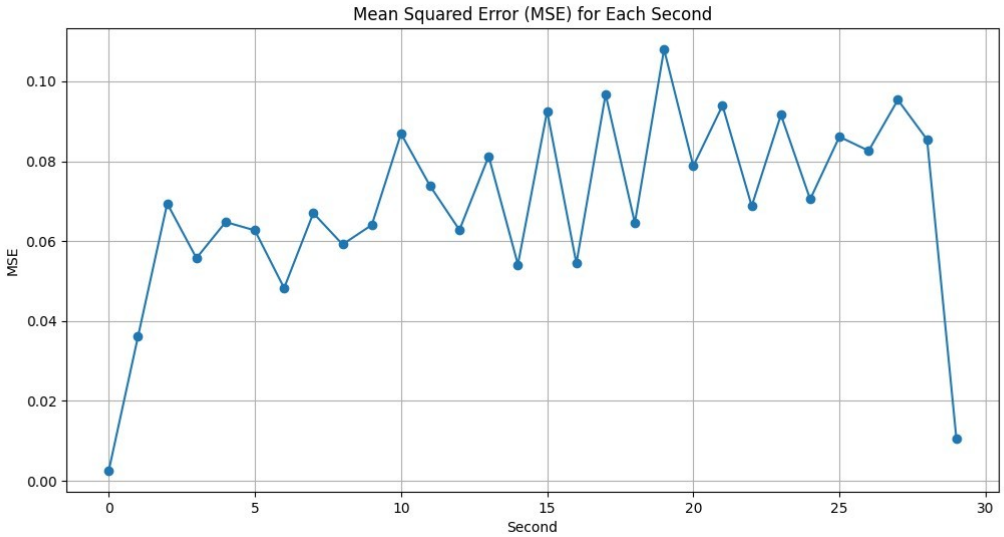
Given below are the evaluation plots for Raw Data











Discussion

This study demonstrates the potential of deep learning models in reconstructing auditory stimuli from EEG data, highlighting significant implications for brain-computer interfaces (BCIs) and neuroprosthetics. The results also reveal the trade-offs involved in preprocessing EEG data: techniques like ICA may remove important neural information crucial for accurate audio reconstruction. The higher MSE scores obtained from raw EEG data were accompanied by audio reconstructions perceived as clearer, suggesting that raw EEG signals may retain subtle neural patterns essential for capturing the full richness of the auditory experience. Future research should focus on optimising preprocessing strategies to retain meaningful information while minimising noise and artefacts. Additionally, more sophisticated models that handle raw, noisy data could improve reconstruction quality.

Lack of Haptic-Sound Symbolism in Congenital and Late Blind Population

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Introduction

Crossmodal correspondence is a fundamental feature of sensory perception. This phenomenon also underpins sound symbolism, where words have non-arbitrary relationship with their meanings. The most famous sound symbolism, the "bouba-kiki" effect, association of 'bouba' with rounded shapes and 'kiki' with angular shapes. This effect is prevalent in about 95% of

English speakers and is observed globally across diverse linguistic and cognitive styles (Sidhu & Pexman, 2018). Similar associations exist between words and other sensory modalities, such as sound and touch (Fryer et al., 2014), sound and taste (Crisinel & Spence, 2009), and kinesthetic movements (Fontana, 2013). However, the role of vision in these associations, particularly in sound symbolism, has been a subject of debate.

To explore the influence of visual input, researchers have studied haptic-sound symbolism in congenitally blind individuals. In these studies, typically the participants were asked to touch objects with varying properties like roughness, roundness etc. and match them with pseudoword sound stimuli. Consistently, congenitally blind participants did not demonstrate haptic-sound symbolism, while late blind participants showed mixed results. In this study, we performed three experiments to assess haptic-sound symbolism across three participant groups:

Congenitally Blind (CB), Late Blind (LB), and Normally Sighted (NS).

Methods

A total of 53 participants took part in the study, They were divided into three groups:

Congenitally Blind (CB, n=22, 2 female, mean age: 23.6), Late Blind (LB, n=9, 0 female, mean age: 25.7), and Normally Sighted (NS, n=22, 4 female, mean age: 20.5). All the participants performed three haptic-sound symbolism experiments. They listened to sound stimuli through headphones and selected one of two objects which resembled the sound stimulus from an opaque bag.

For the first experiment, the pseudowords "laulau" and "zimiti" were used as sound stimuli (Passi & Arun, 2024). In the second experiment, we used phonetically defined pseudowords categorized based on their phonetic features, such as vowel type, consonant voicing, and consonant place of articulation (D'Onofrio, 2014). In the third experiment, we used four naturally occurring textural sounds from a previous study by(McDermott & Simoncelli, 2011). Each participant completed a total of 54 trials, and the frequency of selecting rough/spiky objects (termed 'kiki-ness' ratings) for each sound stimulus was measured and compared across groups.

Results

In the first experiment, NS group exhibited a significant haptic-sound symbolism effect. The

'kiki-ness' ratings for "laulau" and "zimiti" were significantly different from chance level;

"laulau" ($t(21) = -12.339$, $p < 0.001$, Cohen's $d = -2.631$) with rounded shapes and "zimiti" ($t(21) = 4.695$, $p < 0.001$, $d = 1.001$) with spiky shapes.

In the second experiment, the NS group again showed significant haptic-sound symbolism, with 'kiki-ness' ratings significantly different from chance level. For back vowels, the 'kiki-ness' rating was lower ($t(21) = -3.110$, $p = 0.005$, $d = -0.663$), while for front vowels, it was higher ($t(21) = 2.883$, $p = 0.010$, Cohen's $d = 0.604$). Voiced consonants were associated with rounded shapes ($t(21) = -4.308$, $p < 0.001$, $d = -0.918$), while voiceless consonants were associated with spiky shapes ($t(21) = 5.289$, $p < 0.001$, $d = 1.128$). The labial consonants had a significant association with rounded shapes ($t(21) = -6.648$, $p < 0.001$, $d = -1.417$), while alveolar consonants were associated with spiky shapes ($t(21) = 3.940$, $p < 0.001$, $d = 0.840$). No significant association was observed for velar consonants ($t(21) = 2.010$, $p = 0.057$).

In the third experiment, NS group showed significant sound symbolism for all four natural sounds, the kikiness ratings differ significantly from chance level: ($t(21) = 4.042$, $p < 0.001$, $d = 0.862$), ($t(21) = 11.297$, $p < 0.001$, $d = 2.409$), ($t(21) = -4.430$, $p < 0.001$, $d = -0.944$), and ($t(21) = -6.203$, $p < 0.001$, $d = -1.322$). These significant associations were not found in the LB and CB groups.

Discussion

Our study confirms the previous findings that congenitally blind individuals do not exhibit haptic-sound symbolism. They did not associate 'bouba-like' words with smooth/rounded objects or 'kiki-like' words with rough/angular objects. The Late blind participants also did not show these correspondences, suggesting that the absence of visual input may lead to a lack of haptic-sound symbolism. Some previous studies had found crossmodal associations between touch and sound in late-blind individuals, and had concluded that visual experiences in a sensitive period were enough to establish and maintain this crossmodal association. However, our results do not support such a conclusion. The LB group's lack of sound symbolism and the NS group's consistent haptic-sound associations across all experiments indicate that these correspondences are actively maintained by visual input rather than being a result of visual imagery alone.

In conclusion, our study suggests that haptic-sound crossmodal correspondences are not driven solely by visual imagery or a long sensitive period but require ongoing visual input for maintenance. The use of phonetically defined stimuli did not elicit haptic-sound symbolism in blind participants, reinforcing the idea that visual input plays a critical role in these associations.

Session 4

The Effect of Depressive Symptoms, Post-Traumatic Growth, and BRCA Gene Mutation on Attentional Bias Towards Body Image and Acceptance of Femininity among Breast Cancer Patients

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Introduction

The study investigates the relation between depressive Symptoms, post-traumatic growth and BRCA gene mutation on attentional bias towards body image and acceptance of femininity among breast cancer patients who underwent surgery for breast removal.

Breast Cancer ranks as the second most prevalent form of cancer, and the leading cancer diagnosis among women (Sathishkumar et al., 2024). In India, the 5- year survival rate is 66.1% (2010-2014) (Allemani et al., 2018). 27.8% of Indian women with breast cancer experience significant psychological distress such as anxiety, depression and body image disturbances (Dadheech et al., 2023). The emotional turmoil from diagnosis and treatments such as mastectomy and chemotherapy to fulfil traditional familial roles exacerbates these issues. This conflict increases body image concerns and complicates the acceptance of femininity as women struggle with physical changes and their impact on self-identity (Daniel et al., 2021).

Body image issues are a common problem among breast cancer survivors after mastectomy. Trends state that 69.3% of women who had undergone mastectomy report feeling less attractive and decreased sexual identity and quality of life. These factors contributed to a profound impact on the acceptance of femininity (Faria et al., 2021). Women tend to connect breast size to societal ideals of beauty and acceptance of femininity (Turk & Yilmaz, 2018). Li (2022) reveals a strong correlation between body image concerns and depression, with those experiencing body image issues being 3.5 times more likely to develop moderate depression. This states the need to address body image concerns and acceptance of femininity in breast cancer survivors, particularly in the context of mastectomy.

BRCA Gene Mutation further complicates the relation with body image and acceptance of femininity after mastectomy. It results in scarring, disfigurement, and loss of sensation (Torrisi et al., 2021). This altered body image can lead to disruption of self-esteem and sexual satisfaction (Hayes et al., 2023), making it essential for women to accept their new physical form to maintain positive growth in the acceptance of femininity.

While qualitative studies have explored the emotional and experiential aspects of these concerns, there is a need for quantitative research design and understanding from a cognitive viewpoint to deepen our understanding of the psychological impacts.

Post-traumatic growth (PTG) and resilience can facilitate recovery in some patients. However, the relationship between PTG and body image is complex, with a study indicating a negative correlation between higher levels of PTG and body image (Wang et al., 2024). Social support plays a mediating role in this relationship, potentially reducing the negative effects of poor body image on PTG. (Li, 2022)

Studies on attentional bias have shown that individuals with body dissatisfaction (Cass et al., 2020), exhibit heightened attention towards negative body-related stimuli. This cognitive tendency can increase feelings of inadequacy and dissatisfaction with their bodies, potentially intensifying the impact on femininity and self-perception. The promotion of idealised body

images in media can further complicate these attentional biases, leading to a cycle of negative self-evaluation and reinforcement of body dissatisfaction (Xie et al., 2023). There are a lack of studies focusing on the attentional bias towards body image and acceptance of femininity in Breast Cancer Patients.

Methods

The study took place at AIG Hospital after obtaining ethical approval from the University and the Hospital's ethics committee. A sample of 19 individuals (M_{age}= 49 years, SD_{age} = 9.81 years) participated. The study uses a quasi-experimental factorial design. The Sociodemographic Data Form was used to collect necessary demographic and clinical information. The participants will need to complete three primary assessments. The Emotional Stroop Test is a widely utilised tool that measures attentional bias towards emotional stimuli (Williams et al., 1996). The task was presented in a 15-inch Lenovo ThinkPad Laptop in Psychopy Version 2023.2.3. The task consists of 10 words each related to body image issues and acceptance of Femininity Concerns and 10 neutral words. Their task is to identify the ink color, without reading aloud the word. A longer response time indicates an attentional bias towards emotionally arousing words. The Beck Depression Inventory (Beck et al., 1961), (Cronbach's alpha = 0.91) and the Post-Traumatic Growth Inventory (PTGI) (Tedeschi & Calhoun, 1996), (Cronbach's alpha = 0.75), are used to measure Depressive Symptoms and PTG. The data on the presence of BRCA Gene is collected from the participant's medical profile.

Results

The preliminary results and trends are presented and discussed. The final analysis will be completed by the time of the conference. Participants with BRCA gene mutation (n = 7) had higher mean depressive symptom scores (M = 22, SD = 10.7) and lower post-traumatic growth scores (M = 43.4, SD = 9.52) compared to those without the gene (n = 12), who had mean depressive symptom scores of (M = 17.8, SD = 6.46) and post-traumatic growth scores of (M = 60.7, SD = 20.5). The BRCA non-mutation group also showed longer reaction times for femininity word stimuli (M = 2047 ms, SD = 977 ms) and body image word stimuli (M = 2018 ms, SD = 660 ms) compared to the BRCA-negative group, whose reaction times towards were Femininity word stimuli (M = 1521 ms, SD = 606 ms) and Body Image word Stimuli (M = 1363 ms, SD = 646 ms).

Discussion

This study investigates how depressive symptoms, post-traumatic growth, and BRCA gene mutation influence breast cancer patients' attentional bias towards body image and their acceptance of femininity after undergoing breast removal surgery. The study highlights the significant impact of BRCA gene mutation on depressive symptoms, post-traumatic growth, and attentional biases toward body image and acceptance of femininity in breast cancer patients. The BRCA mutation group exhibited higher depressive symptoms, lower post-traumatic growth, and longer reaction times to emotionally charged stimuli, indicating heightened sensitivity to body image and femininity concerns. These findings suggest the need for modified interventions focusing on mental health regarding body image and problems arising from the self-perception of femininity. Further Inferential analysis should be done to understand a more robust relation between depressive symptoms, post-traumatic growth, BRCA Gene mutation and attentional bias towards body Image and acceptance of Femininity.

The Impact of Socioeconomic Disadvantage and Parental Alcohol Abuse on Children's Executive Functions in Urban India: A Pilot Study

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Introduction

Socioeconomic status (SES), a composite of income, education and occupation, is a key predictor of quality of life, opportunities afforded to people within society and various psychological outcomes [1]. Socioeconomic disadvantage (lower SES)—manifesting as poverty, unsanitary housing, malnutrition and poor schooling—adversely impacts children's cognitive development [2]. This may be exacerbated with concomitant Parental Alcohol Abuse (PAA), which interferes with parents' ability to provide a safe, nurturing environment. With children suffering from neglect/maltreatment, the risk of poor developmental outcomes may be compounded [3].

Executive Function (EF) development is vulnerable to environmental influences. Positive environments foster EF development, whereas negative influences like poverty, trauma and chronic stress are linked to deficiencies [4]. Core EFs, constituting inhibitory control, working memory and cognitive flexibility [5] demonstrate notable fragmentation, indicating that they encompass distinct/separable characteristics [6]. Therefore, disparities in SES and PAA may differentially affect core EFs.

Studies have examined the impact of SES and PAA on EFs separately, but their impact on specific EFs is unknown. Some link low SES to working memory/ inhibitory control deficiencies, but exclude a measures of cognitive flexibility [7, 8]. Moreover, the interaction between SES and PAA remains unexplored.

EF deficiencies can impair daily functioning, capacity for goal directed behaviour, attainment of success and psychological well-being; rendering such an investigation imperative [9].

Methods

Sixty children (Mean $_{age}$ = 12.30; SD = 1.86) aged 10-15 years, equally distributed by sex and SES, participated in this study. The Kuppuswamy Scale was used to categorize SES, while EFs were assessed using the Mackworth Clock Test (MCT), Digit Span Task (DST) and Trail Making Test (TMT-A & B), on the Psychology Experiment Building Language (PEBL). The self-report version of Alcohol Use Disorders Identification Test (AUDIT) was used to measure presence/absence of PAA.

A two-way ANOVA analysed the main and interaction effects of SES and PAA on EFs. The between-group subjects included SES (high vs. low) and PAA (present vs. absent). The withingroup subjects included accuracy and reaction time (RT) of inhibitory control, working memory and cognitive flexibility. Analyses were performed using SPSS.

Results

The SES groups did not differ significantly from each other in age (p >0.05) or sex assigned at birth (n=30 males; n=30 females). No significant interaction effects were observed between SES and PAA on EFs. However, SES and PAA exerted significant main effects on the accuracy and RTs of core EFs.

Participants in the low SES group performed less accurately on tests of inhibitory control ($F(1,56)=15.681$, $p=.002$; $\eta p2=.225$); working memory ($F(1,56)=27.115$, $p<.001$; $\eta p2=.375$); and cognitive flexibility: TMT-A ($F(1,56)=97.742$, $p<.001$; $\eta p2=.646$) as well as TMT-B ($F(1,56)=91.985$, $p<.001$; $\eta p2=.623$), after controlling for age and sex. Participants in the low SES group also had longer mean RTs on the test of working memory ($F(1,56)=8.390$, $p=.044$; $\eta p2=.134$). PAA exerted a significant main effect on the accuracy of performance only on the test of cognitive flexibility: TMT-A ($F(1,56)=18.737$, $p=.001$; $\eta p2=.229$) as well as TMT-B ($F(1,56)=21.900$, $p<.001$; $\eta p2=.268$).

Discussion

Findings suggest that while both SES and PAA independently impact children's EFs, SES is of more import. Socioeconomic disadvantage has a more adverse impact on EFs than PAA alone. However, SES and PAA do not compound each other's effects, perhaps due to the following factors.

The extent to which cognitive deficits in children of parents with Alcohol Abuse Disorder (AUD) may stem from poor home environments and/or genetic factors is contended. Albeit AUD contributes to EF deficits, poor EFs in adolescence also predicts AUD development [10]. Thus, EF deficits seen in AUD may be pre-morbid [11], suggesting that their children might inherit these deficiencies [12], independently of SES. This complexity could partially explain the absence of an interaction between PAA and SES. Furthermore, PAA, prevalent across both SES groups, occurred frequently in lower SES households where the abuser parent was absentee, reducing their direct environmental impact on children. The small sample size might have also obscured interaction effects.

Despite the absence of significant interaction effects, this pilot investigation provides foundational data on the impacts of SES and PAA on children's EFs, highlighting the need for further research with a larger sample.

Keywords: Executive Functions, Socio Economic Status, Parental Alcohol Abuse, Cognitive Development.

Studying the Role of Gamma oscillations in Motor Control using a bio-inspired Actor-Critic based Oscillatory Neural Network

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We recently proposed a general, unified bio-inspired agent model that can model a variety of cognitive constructs including goal oriented selective attention, distractor suppression, decision making, response inhibition and working memory. Unlike the customary approach wherein distinct models are proposed to explain isolated cognitive functions, in the above case a single model explains a wide range of cognitive functions. Subsequently, the working memory capabilities of the above model were further amplified and demonstrated in complex sequence processing tasks. The model was essentially a Reinforcement Learning (RL) agent, and inspired by the functional architecture of the Basal Ganglia (BG). Although the above model named Generalized Reinforcement Learning-based Deep Neural Network (GRLDNN), had its origins in the BG, it is being developed into a generic bio-inspired RL agent model with versatile capability.

One lacuna in GRLDNN, however, is the absence of oscillations. Brain dynamics is often described in terms of distinct oscillatory bands like alpha, beta, gamma etc. Through a large body of empirical studies, these oscillatory bands have been associated with specific sensory, motor, cognitive and affective phenomena in normal and pathological conditions (Buzsaki, 2016). These phenomena are often modeled using networks of nonlinear oscillators. Deep neural networks are used extensively to implement RL agents, but to our knowledge, there are no RL models that combine deep neural networks and oscillators.

Therefore, in this paper we expand GRLDNN by incorporating nonlinear oscillator layers. The model, dubbed Actor Critic Oscillator Reinforcement Neural Network (ACORNN), is used as a trainable controller for simple control problems in which the plant has easily understandable oscillatory dynamics. The motivation is to see that the oscillators in the model learn the underlying oscillatory dynamics of the plant, in order to solve the control problem. We expect that such models can be used to investigate the oscillatory activities of brain regions involved in RL.

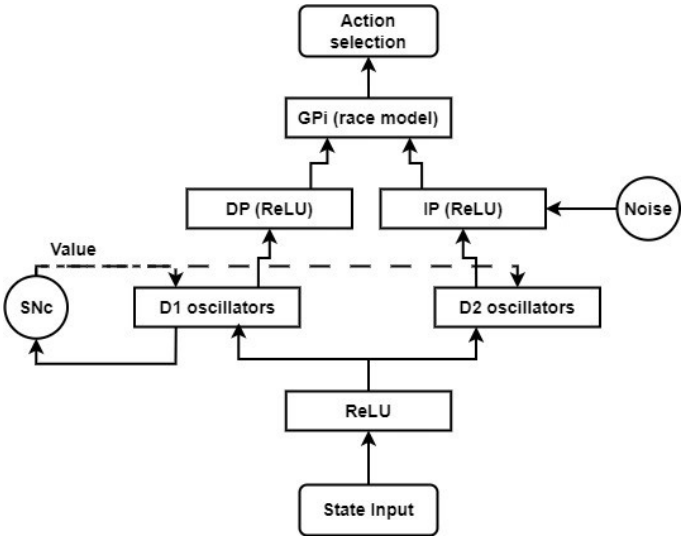
Model Architecture

The ACORNN model inspired by the BG consists of a cortico-striatal layer that gets input from the cortex (Fig. 1). The output of the cortico-striatal layer is fed as an input to the oscillators in Striatum. The Striatum has two sublayers, labelled D1 and D2, fashioned after the D1 and D2 expressing neurons of the biological Striatum. The oscillators used are Hopf oscillators with the dynamics described in the complex domain, where the input $I(t)$ to the oscillator i is given in the amplitude modulation mode as follows:

$$dr/dt = (I(t) - r^2)r$$
$$d\phi/dt = \omega_i$$
$$z_i = r(cos\phi + i\ sin\phi)$$

where ω_i is the intrinsic frequency and z_i is the output of the i'th oscillator. The intrinsic frequencies of the striatal oscillators are in the gamma range [20-80Hz]. The output from D1

oscillators are projected to the Substantia Nigra pars compacta (SNc) layer to calculate Value and this part of the acts as the Critic. The outputs of striatum (D1 and D2 oscillators) are fed via direct and indirect pathways to Globus Pallidus interna (GPi). The GPi makes the control decision using the "race" model (Kumari, 2022). Although the striatal oscillators are in the gamma band, the GPi essentially performs some sort of a demodulation operation to bring the output to the frequencies of the motor action. External uniform random noise is added to the indirect pathway for exploration.



/Figure 1. Architecture of the proposed oscillatory Actor Critic model.

Methods and Experimental setup

The control task used in this work involves a swinging pendulum. The goal is to choose an action such that the pendulum with massless string attached with mass of m and damping coefficient of 0.1N/m should maintain a minimum amplitude by overcoming damping. The three possible actions are: torque towards left (-1Nm) and right (1Nm), and no action (Fig. 3).

The actor-critic loss used is mentioned in Fig. 2 below.

$$L = L_{actor} + L_{critic}$$

$$L_{actor} = -\Sigma_t [log(A\ (a_t|s_t))(r - C\ (s_t))]$$

$$L_{critic} = (G_t - C\ (s_t))^2$$

$A\ (a_t|s_t)$ - probability of winning action a_t at state s_t by policy network (actor)

$C\ (s_t)$ - value function by critic

$G_t = \Sigma_k \gamma^k R_{t+k}$ where $\gamma = 0.9$ is the discount factor and R_t is the reward at time t

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Figure 2. Actor-critic loss used

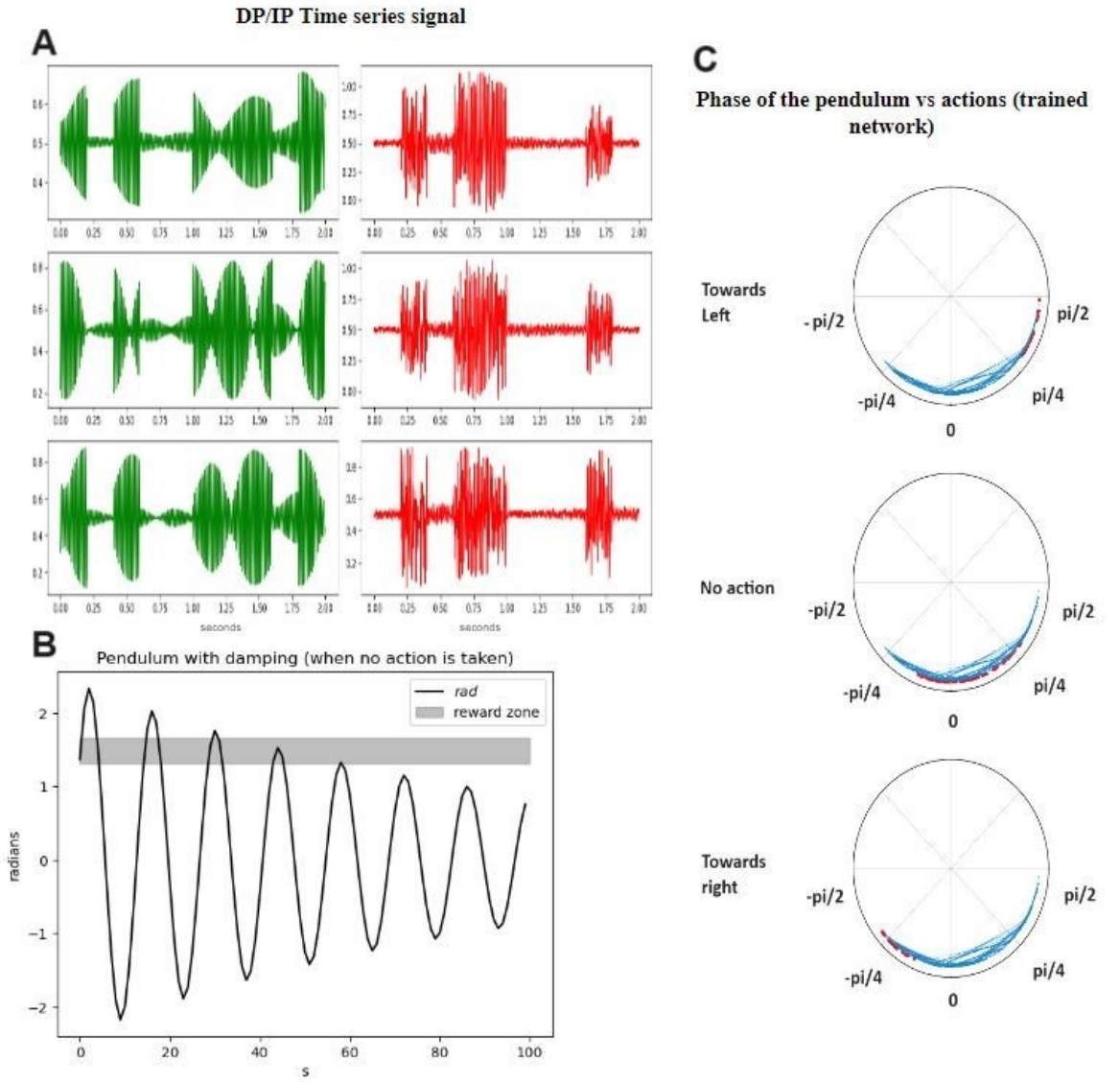

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Figure 3. A) Output of DP/IP (red/green) neurons corresponding to three actions of an episode. B) Swinging pendulum reward setup – reward is given whenever the angle of the pendulum enters the gray band. C) Phases of the pendulum at which actions (red dots) are taken by the trained network (0 radian denotes downwards vertical).

Results

The ACORNN model is trained on the swinging pendulum task and can learn to attain the maximum reward condition. Apart from standard learning and performance metrics, two further analyses are performed: i) synchrony in low vs high value regimes and ii) peak frequency in action spectrum for varying lengths of pendulum. The aim of the analyses is to showcase the potential advantages of the current model to explain complex observations in neurophysiological data, which standard computational models will find difficult to explain.

High vs low value regimes in the swinging pendulum task are extracted during testing and synchrony within D1 and D2 oscillators are calculated. Unlike in standard actor-critic networks, the current model uses continuous time varying value function (dt=4ms) because of oscillatory activations. Synchrony (S) within a group of oscillators is calculated using,

/ $T1 \quad N1 \qquad (t))$

$$S = \quad \Sigma t(\Sigma i z n,i$$

where the complex number $z_{n,i}(t)$ is normalized from $z_i(t)$ such that $z_{n,i}(t)$ lies on the unit circle. During high value regime, the synchrony within D2 oscillators is higher than that of D1, but in low value regime, D2 is less synchronous than D1 (Fig. 4). This observation suggests that D2 is de-synchronizing so as to explore the action space during low value states. Thus, the proposed model shows GEN (Go-Explore-NoGo) regimes based on the value function computed using the environment state (Chakravarthy, 2015).

For the second analysis, the length of the pendulum is varied (L=0.1-1m) and the corresponding peak frequency of the action spectrum is calculated. It is observed that, for a particular length L, the peak frequency of action spectrum (actions - torque towards left and right) matches with the pendulum frequency (Fig. 5). Also, by varying length L, the shift in weighted mean frequency of D1 oscillators output is also observed (Fig. 6).

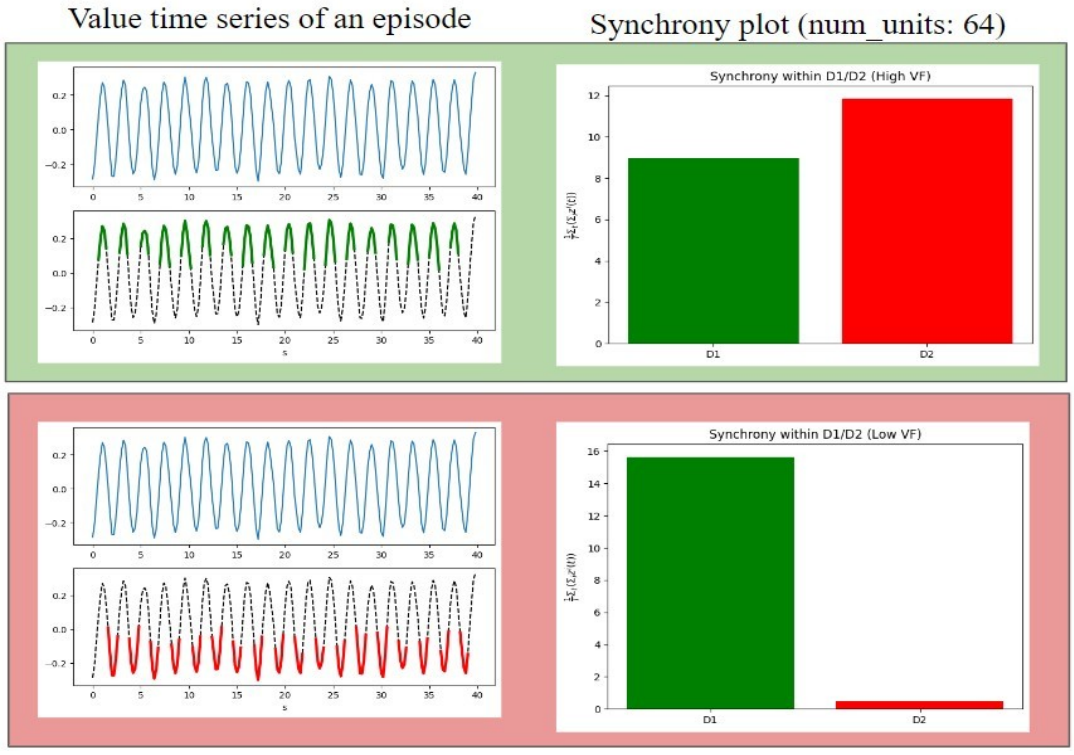

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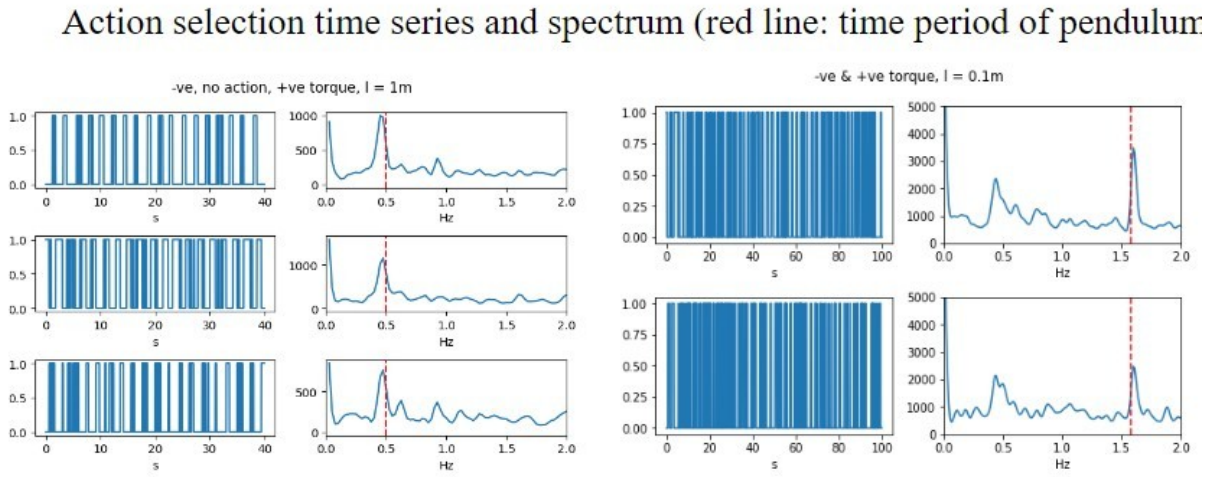
Figure 4. Value function plot (left) and synchrony plot within D1 and D2 (right). Value function plots (green and red) denote high and low value regimes respectively.



/ Figure 5. A) Action selection plot (left) and spectrum plot (right). Red line denotes the frequency of the pendulum.

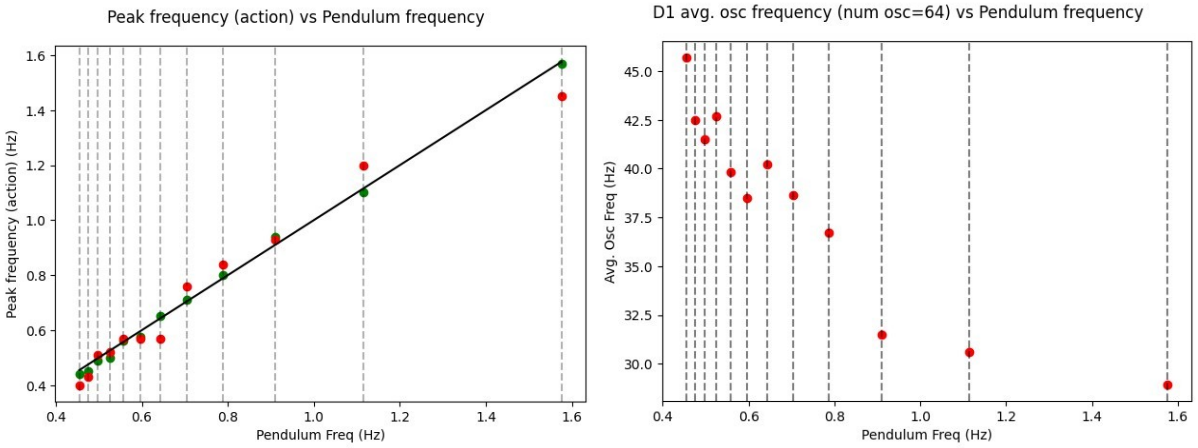


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Figure 6. (Left) Peak frequency in action spectrum (+ve and -ve torque actions) vs pendulum frequency. (Right) Weighted-mean frequency of D1 oscillators vs. pendulum frequency.

Discussions

Gamma oscillations in BG, prefrontal cortex and motor cortex have been shown to perform a widevariety of functions in motor-control tasks (Jenkinson et. al., 2014). However, there seems to be no definitive theory that explains the specific significance of gamma range frequencies to performing a particular motor-control task. Particularly, the role of high gamma (70-200 Hz) and low gamma (30-60 Hz) in performing motor tasks is not clear. In a study conducted by (Isabella et al., 2015), for a Go/No-Go task, inhibition to switch was reflected in increased high-gamma power. In (Wiesman et. al. 2021), increased power in high-gamma is observed during movements performed in non-familiar context. Also, increased high-gamma activity in STN is observed when force and speed demanded to do the task is increased (Brucke et al., 2012; Alhourani et al., 2020). The proposed oscillatory Actor Critic model can be used to understand the role of gamma oscillations and its sub-bands (low vs high gamma) in performing motor-control tasks. The model can also be extended further to understand coupling interaction between other frequency bands in sensorimotor interactions.

The Sunshine Effect: The Impact of Vitamin D Deficiency on

Physical and Mental Health

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Rai, Pooja; Pradhan, Hitesh; Sundarakumar, Jonas
IISc

Introduction

Vitamin D (Vit D) deficiency is a global concern, with far reaching implications. It is a commonly underreported problem that is highly prevalent in both high as well as low and middle-income countries (LMICs). Vit D deficiency has been linked to balance issues (Pfeifer et al., 2000), increased fall risk (Bischoff-Ferrari et al., 2004), reduced muscle strength
(Bischoff et al., 1999) and executive functioning (Robertson et al., 2013).
However, vit D levels are susceptible to geographical factors, and literature on its prevalence and impact on health outcomes from LMICs are sparse. This study aims to examine the association of vit D deficiency with depression and physical performance.

/Methodology

The study included a baseline cross-sectional data of 6550 participants from the Centre for Brain Research-Srinivasapura Aging, NeuroSenescence and COGnition (SANSCOG) cohort. Sociodemographic data including age, education (in years), sex, BMI (Body mass index) occupation, marital status and income, were assessed during clinical assessments. The study also considered hypertension (HTN), diabetes mellitus (DM) and dyslipidaemia (DYS) status to evaluate the impact of comorbidities on their well-being. The current use of smoking and alcohol was measured via self-reports.

Participants were categorized into three clinically relevant groups based on their vitamin D levels, not deficient (> 20 ng/dL), mild deficiency (between 10 to 20 ng/dL) and deficient (< 10 ng/dL).

The Geriatric depression scale (GDS-30) was used to assess self-reported depression; Hand grip strength (HGS) to evaluate upper body strength, using the Camry -EH101 electric hand dynamometer and Timed-up and Go (TUG) test was used as a measure of functional mobility, gait and balance.

Demographics were reported as frequency, mean and SD. Logistic and Linear regression assessed associations between vit D levels with GDS-30, HGS and TUG, adjusting for age, gender, education and other factors. The analysis was performed using Jamovi (v2.3).

Results

Participants (mean Age =59.1 ± SD=9.6) in our study were unevenly distributed across vitD groups, with 69.15%, 27.7% and 3.1% participants in the not deficient, mild deficient and deficient groups, respectively. The sample characteristics showed significant group differences between occupational levels and vit D deficiency (p =0.012).
The fully adjusted logistic regression model showed a significant association between mild deficiency and depression ratings (GDS score ≥10) compared to the not deficient group (OR:

0.85; 95% CI:0.7-0.9; $p < .05$). Additionally, fully adjusted linear regression models showed that individuals in the mild deficiency group performed worse in the TUG test (β= -0.16; 95% CI: .001-.101; $p<.05$), but no significant differences were observed in the HGS performance between these groups. Moreover, there were no differences in depression levels or physical performance between the deficient and the not deficient group.

Discussion

Higher rates of deficiency were observed in participants who worked as skilled workers (129, 2.0%) and unskilled workers (70, 1.1%), who typically engage in outdoor work. This finding contrasts with existing literature suggesting that individuals with lower sun exposure (indoor workers) are more likely to develop vit D deficiency (Sowah et al., 2017). Additionally, it is important to note that most of the participants (5296, 80%) also reported low individual income. Owing to this a reasonable explanation for this high prevalence of deficiency in a population that predominantly works outside could be their poor dietary habits (Cashman et al., 2018).

The main outcome variables of the study were mental and physical health measures. The presence of clinically significant results on depression scale is consistent with existing literature (Annweiler C et al., 2010; Cuomo et al., 2019). The poorer performance on the TUG test indicates towards a reducing functional mobility (Pfeifer et al., 2000) and could further lead to disability.

The increase in physical dependence has been found to be a marker of cognitive impairment and is further mediated by the presence of depression (Robertson et al., 2013). Recent studies also suggest reduction in domain specific cognitive performance, primarily in executive functioning and processing speed in individuals with declining physical functioning (Halil et al., 2015).

Our study highlights the need for early intervention and psychoeducation on the debilitating effect of vitamin D deficiency on everyday functioning.

Keywords: Vitamin D deficiency, Depression, Physical Functioning

Spatial Location Encoding of Auditory Sources in the Human Brain: An EEG Study

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Introduction

The ability to localize a sound source is a fundamental aspect of our navigation and survival. Most of the previous work on sound localization focuses on two primary mechanisms: Interaural Intensity Difference (IID) and Interaural Time Difference (ITD) (Middlebrooks et al., 1991). However, in addition to other important factors like the structure of the pinna and the spectral content of the cue that contribute to our localization ability, strong evidence exists for monaural sound localization, which cannot be accounted for by just these mechanisms. Hence, the primary focus of this study is to understand the neural mechanisms underlying sound localization and to investigate whether the location of an auditory source is embedded in the neural signature activity, which is time and phase-locked to the stimulus.

Methods

The study was conducted in-house at IIT Gandhinagar, involving 29 participants (all students of the institute) with no reported hearing or mental conditions and no reported musical training. The experiment employed a set of 12 mathematically generated tones, simulating naturalistic piano tones that were carefully selected to be distinguishable and within the frequency range below 500 Hz, aligning with the Nyquist frequency of the EEG sampling rate of 1000 Hz. These tones were presented through six equidistant speakers arranged around the participant in a controlled environment. The experimental procedure consisted of three phases: pre-training behavioral, training (free-listening), and post-training behavioral. During the behavioral phases, participants were asked to localize the sound source on a touchscreen monitor, while in the training phase, they passively listened to the tones. The tones were divided into localized and non-localized sets, with each localized tone being only played from its respective speaker and the non-localized tones being played from any speaker chosen at random.

EEG was recorded during the entire duration, and extensive pre-processing steps were carried out, including re-referencing, band-pass filtering, Independent Component Analysis (ICA), and ICLabel classification to remove artifacts. The data was then epoched from -200 ms to 800 ms post-stimulus onset, based on the trials of interest with a baseline from -200 ms to 0 ms. EEG data analysis was performed for 12 participants. Behavioral data, indicating the perceived location of auditory sources, was also recorded and analyzed.

Results

We looked at the time and phase-locked Event-Related Potential (ERP) and did a time-frequency transform to get Event-Related Spectral Perturbation (ERSP) signals to understand how auditory spatial location is encoded with three regions of interest: left-parietal (E-L), right-parietal (E-R), and central (E-C) brain regions. We find that ERSP signals in the alpha frequency range are significantly higher in the ipsilateral parietal areas than in the central regions. We also find that the parietal region ipsilateral to the auditory source gives a higher ERSP amplitude in the alpha frequency band than the parietal region contralateral to it, although the differences were not statistically significant (which can possibly be attributed to the variance in the peak frequencies in the alpha range across participants in addition to the low sample size of 12 participants). These results show that location information is preferentially encoded in the alpha band in the ipsilateral parietal areas. The behavioral data

indicated that participants were generally able to localize the auditory stimuli accurately with an increased localization performance for the tones from the localized set.

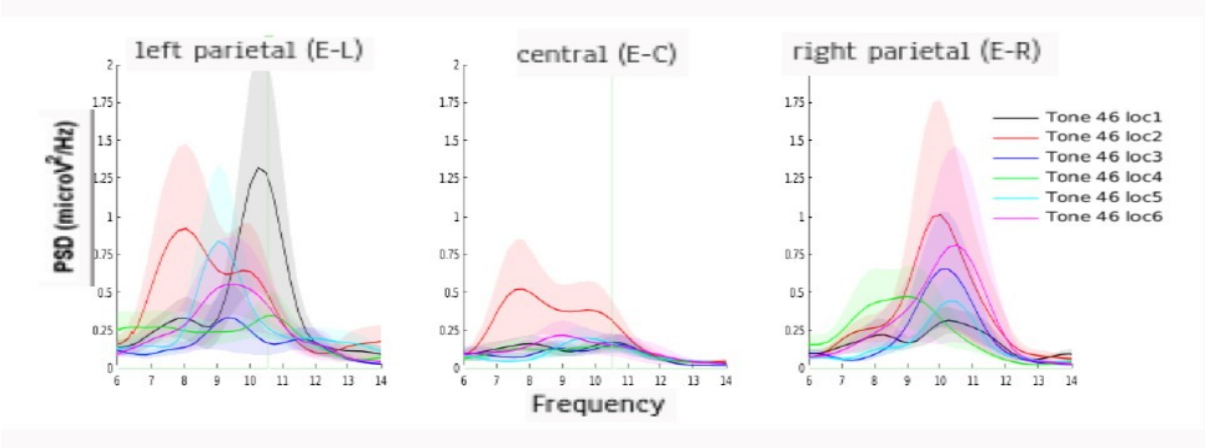

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Fig 1**:** Power spectral density grand average ERSP graph across 6 different stimulus locations for E-L, E-C, and E-R (for tone 46).

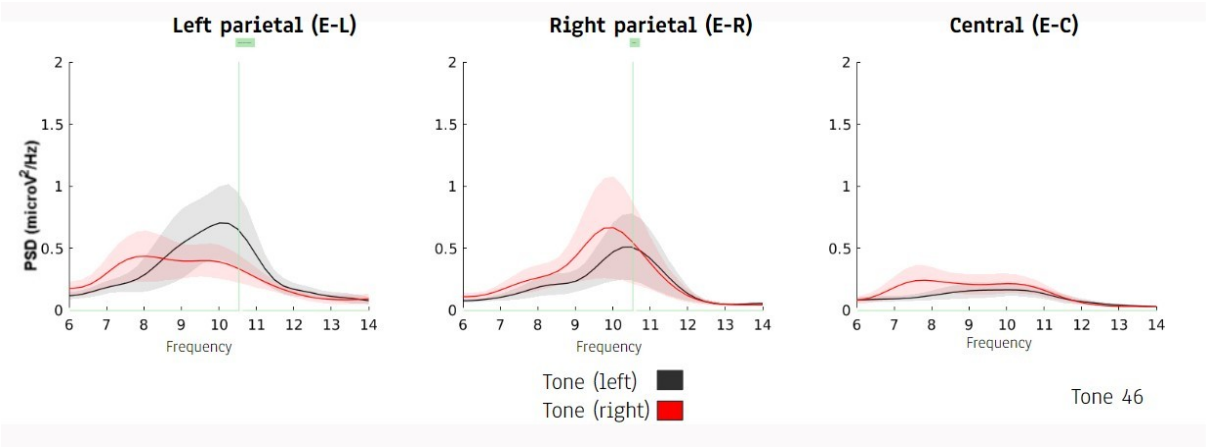

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Fig 2: Power spectral density grand average ERSP for E-L, E-C, and E-R for stimulus in left versus right condition.

Discussion

Our study highlights differences in the encoding of spatial information of auditory stimuli between the ipsilateral and contralateral parietal regions in the alpha frequency band and a significantly higher preferential encoding in the ipsilateral parietal region than in the central region which supports the findings of Deng et al. (2020). Our experimental design enables us to test a few more questions, including how the localization of a tone changes the neural signature properties of the stimuli, the data for which has already been collected. Previous research on various modalities have provided evidence for such asymmetrical representation in the parietal hemispheres (Banerjee et al., 2011) and our study adds to it, giving further evidence for an asymmetrical supramodal representation in the parietal cortices.

Perceptual load influences gradedness of awareness of gist in visual scenes in a dual task: Gist perception is more graded in high load

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Introduction

The discrete or gradedness of consciousness continues to be a topic of contention in consciousness research. Theories of consciousness such as the Global neuronal workspace theory (GNWT) posits awareness to be a discrete phenomenon with only two states – fullawareness, or no-awareness (Vugt et al., 2018). GNWT postulates that once stimulus activation crosses the threshold level, it results in a sharp and almost discontinuous transition from an unconscious state to conscious experience. On the other hand, other theories such as the Radical plasticity hypothesis (RPH) (Cleeremans et al., 2020) posits awareness to be a continuous and graded phenomenon. It is also postulated that gradedness is flexible and factors such as attentional mechanisms, stimulus property in the perceptual hierarchy, and task related factors might influence the all-or-none or graded nature of awareness (Fazekas & Overgaard, 2018).

In terms of theories of attention based on resource capacity like load theory (Lavie, 1995), load has been proposed to influence visual awareness (Lavie et al., 2014). It is not clear how load influences gradedness of visual awareness when the task of interest is a secondary task and load is manipulated for a concurrent task. In addition, studies on load have not measured awareness using a perceptual scale. In this study, we investigated this issue by investigating the influence of load on gist perception. We hypothesized more graded awareness during high load compared to low load due to less processing resources available during high load condition. During high load condition, the capacity of attentional system is more exhausted whereas during low load condition it is not.

Methods

Participants

Eighteen volunteers (*M*: 23 years, females: 7) from IIT Kanpur participated in the current study after providing informed consent. All the participants had normal or corrected to normal vision.

The study was approved by the Institutional Ethics Committee.

Stimuli and apparatus

The stimuli were real-world scenes taken from ObScene-database (Andrade et al., 2024) and CB-Database (Sareen et al., 2016) and divided into indoor/outdoor categories. After preprocessing, 257 indoor and 284 outdoor images were selected for the experiment. The contrast of all these images were converted to grayscale and normalized using the histogram equalization method using python. The contrast of these greyscale images was set at 8 levels (3%, 6%, 9%, 12%, 15%, 18%, 21%, 24%) to be used in the current experiment. The presentation of a particular image at a particular contrast was randomized and no image was repeated twice. 20 trials were presented for each contrast level. For both high and low load conditions, six letters were presented on the image as shown in the following trial diagram. For high load condition, participants' task was to identify the letters 'X' or 'N' presented among other letters. In the low load condition 'X' or 'N' was presented among the letters 'O'

as depicted in the trial diagram in figure 1. High and low load conditions were blocked and were counterbalanced across participants.

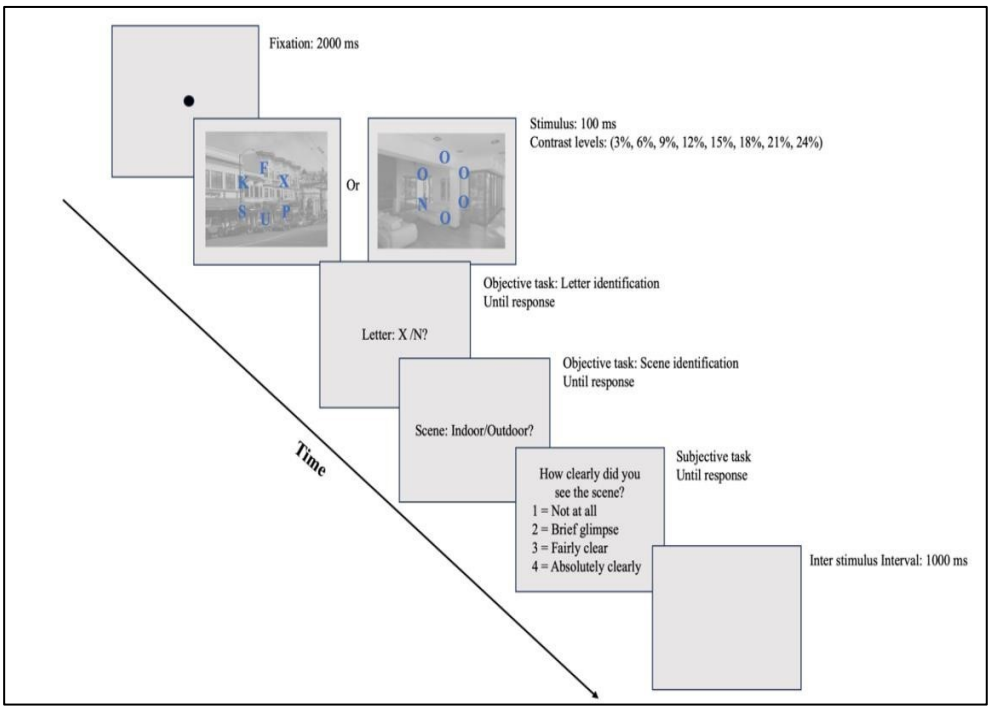

Figure 1. Trial diagram

Results

High load condition task was indeed more difficult compared to low load task. Accuracy rates in the perceptual load letter identification task decreased significantly from low- (M = 89.37%, SD = 6.28%) to the high- (M = 73.61%, SD= 5.91%) load condition, t_{17} = 11.55, p = 0.001, d
= 3.08.

Curve-fitting results

A four-parameter non-linear exponential model was fitted for individual subject's objective performance and subjective clarity rating of the scene. The mean R^2 for all the conditions were around 0.87-0.9. The fits of the curves for mean objective performance and subjective ratings data are shown in figure 2 and 3 respectively. The mean and SD values for all the conditions are given in the Table below.

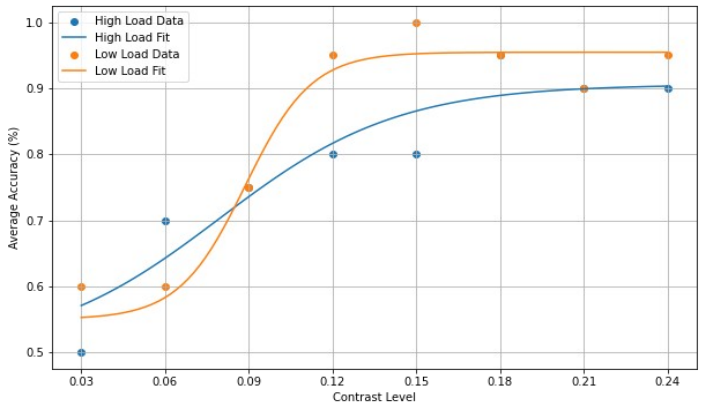

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Figure 2. Fits for average accuracy

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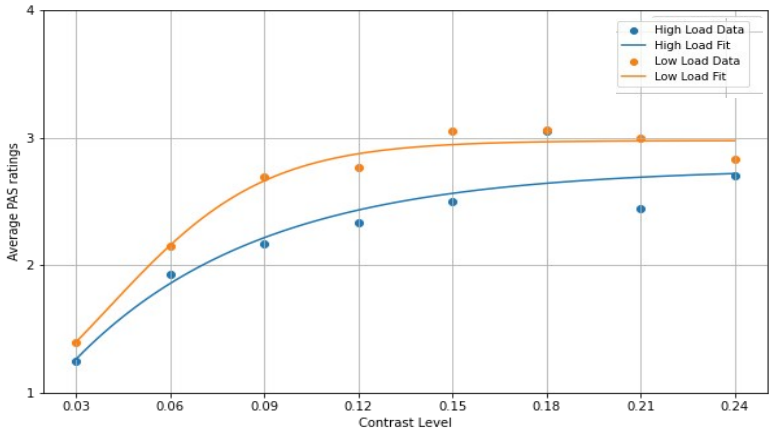

Figure 2. Fits for average subjective-ratings

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Response	Model parameters	High-load		Low-load	
		Mean	SD	Mean	SD
Accuracy	Threshold ‘c’	0.089	0.156	0.086	0.016
	Slope ‘d’	0.018	0.008	0.007	0.009
Subjective-visibility	Threshold ‘c’	0.076	0.033	0.073	0.044
	Slope ‘d’	0.047	0.030	0.031	0.017

Shapiro-Wilk normality test was conducted to test for normality and paired sample t-tests were conducted for all the four conditions. For the objective task, the slope parameter of the psychometric function was significantly different between the high and low load conditions, $t_{17} = 3.26$, $p = 0.006$, $d = 0.87$. However, there was no significant difference for threshold parameter for high and low conditions, $t_{17} = 0.44$, $p = 0.663$, $d = 0.11$. For the subjective task,

the slope parameter of the psychometric function was significantly different between the high and low load conditions respectively, $t_{17} = 2.88$, $p = 0.012$ $d = 0.77$. However, there was no significant difference for threshold parameter for high and low conditions $t_{17} = 0.64$, $p = 0.533$, $d = 0.17$.

Discussion

Current findings show that visual awareness during high load condition is more graded compared to low load condition indicating that gist perception is graded. This is reflected in the slope parameter of both objective performance as well as subjective visibility ratings. Load does influence gradedness of visual awareness. The findings have implications not only for theories of consciousness but more specifically for models of gist perception.

The Impact of Allocentric Shifts in the Emotional Regulation of Autobiographical Memory Recall

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Introduction

Emotional regulation denotes the intrinsic capacity within individuals to effectively manage and regulate their emotional experiences (Gross & Thompson, 2007). Emotions serve a vital evolutionary function in human survival (Frijda, 1986; Ekman & Davidson, 1994). However, when emotions go unregulated, they can negatively impact psychological health and are linked to psychopathology (Aldao et al., 2010).

Individuals vary in emotion regulation skills; while some excel, others may struggle. Emerging evidence suggests that adopting an allocentric shift, which means an observer's perspective, can significantly influence emotion regulation (Lutz et al., 2012). Webb et al. (2012) found that an adoption of an observer's viewpoint regulated emotions, and King et al. (2022) found that this change in one's perspective diminishes affective and self-related information's experiential and conceptual aspects in autobiographical memories by asking participants to manipulate the perspective. This study explored whether shifting to an allocentric (observer's) perspective in autobiographical memories would impact interpersonal emotion regulation. While commonly employed in therapeutic approaches for clinical populations, these findings are proposed to hold broader relevance for work, educational, and other settings.

Methods

A total of 108 participants registered for the study, out of which only 95 participants completed all three sessions of the experiment. An initial screening test was conducted to exclude participants who suffered from any psychological disorder in the past or were on medications that might influence their memory. There were 47 men and 48 women, with an age range of 18-29 years old (M = 21.37, SD = 2.35). The Institutional Ethics Committee approved this study. There were three separate sessions over a period of 10 days. On the first day, participants completed emotional regulation questionnaires to assess their emotional regulation strategies. Next, they were asked to recall their positive, negative, and neutral memories from the past five years and across their lifetimes. After writing these autobiographical memories, participants rated whether their recollections were from their own eyes or the observer's eyes, as well as the emotional intensity of memory after recall. After seven days, in Session 2 , a perspective manipulation was introduced. The participants selected the six most important memories from the previous session and were instructed to write about three of them from their own perspective, and the other three from an observer's perspective. Subjective ratings were again collected for these memories. Session 3 occurred ten days later, where participants were shown only the titles of the memories, and asked to write whatever came into their mind upon seeing the title, without any instruction to maintain perspective. This was again followed by subjective ratings. The study concluded with the administration of the same emotional regulation questionnaires that were given at the beginning of the study to understand if there were any differences before and after the experimental manipulation.

Results

SPSS was used to analyse pre and post-measures of personality characteristics and self-report questionnaires. The personality characteristics included general Happiness, Sadness, Anxiety, and Introversion/Extroversion. Personality characteristics were assessed by the SCATI, a measure of 14 personality disorder traits. There were three self-report questionnaires administered: Difficulties in Emotional Regulation Scale (DERS), the Interpersonal Emotion Regulation Questionnaire (IERQ), and the Emotion Regulation of Self and Others (EROS) to determine if there was a difference in emotional regulation strategies before and after the allocentric shifts.

In the personality characteristics, only Happiness significantly increased with a small effect size. The initial DERS total score, a measure of emotional dysregulation, had significant positive relationships with 10 of the 14 personality disorder (PD) variables. Five of the PD scales, Avoidant, Borderline, Dependent, Depressive, and Self-defeating, produced medium to large effect sizes. The initial EROS total score, a measure of how well a person can regulate their own emotions and their emotional reactions to others, was not well predicted by the 14 PD variables. All 14 PD scales produced less than a medium correlation (r = .30). Similar to the EROS measure, the initial IERQ correlation total score, a measure of strategies where one person seeks to influence the emotions of others or seek help from others to regulate their own emotions was also not well predicted by the 14 PD variables.

Discussion

The preliminary findings suggest that only Happiness significantly increased from pre- to post, and emotional dysregulation was well predicted by the 14 personality disorder traits. The allocentric shift from self to other perspective did not appear to alter the participants' emotional regulation. It is possible that after writing positive or negative memories, the participants used emotional regulation strategies of Venting out and Acceptance of their emotions which helped the participants to feel relieved by writing the details of those memories. Another interesting finding was that the DERS (a measure of emotional dysregulation) was the only measure that increased from pre to post after an allocentric shift. It was expected that emotional dysregulation would decrease after the allocentric shift. This curiosity may be explained by Gratz and Roemer (2004), who proposed that "... attempts to control emotional expression may increase the risk for emotion dysregulation …"

Influence of Semantic Binding on visual search: Interplay of Long-Term and Working Memory

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Thapar School of Liberal Arts and Sciences

Research till now has demonstrated that semantic information is rapidly and automatically extracted from scenes and that semantic context, when relevant or irrelevant to a task, influences attention (Nah, J.C.. et al, 2023). However, whether presence of a semantic context between scene and real world object pairing play a crucial role in influencing attention when both Long term memory and Working Memory stored objects are involved is yet to be

examined. In addition to this, the role of such scene and object pairing interacting with the consistency (near versus apart) of objects in a visual search array also hasn't been investigated yet. This semantic binding between the type of association of real-world scenes and real-world objects with the location of long term encoded and working memory encoded objects will show new understanding of their interplay within the visual search paradigm.

Recently, Hirschstein & Aly (2022) used primarily colors and shapes associated with real world scenes to examine attentional guidance between long term or working memory encoded color/feature-scene pairings when they were spatially consistent or inconsistent. The role of visual search paradigm will provide aid in seeing the influence of scenes and objects when semantically related by picking cues from LTM and WM (Wu C-C et al (2014). The novelty of semantic binding in the visual search paradigm in this experiment leads to interesting observations about how both LTM and WM affect performance. This depends on the type context association and memory being probed.

The current study is part of a research work in progress and provides tentative data trends. Expected $N = 60$ which will be presented in the conference. The current results are based on 4 pilot data collected and the data trend supports the proposed hypothesis.

Hypothesis: Consistent, spatially close semantic arrays should facilitate search times for long-term memory (LTM) objects, while non-semantic working memory (WM) arrays are expected to slow responses. Context-absent arrays (only the prompted object) should enhance search efficiency due to reduced interference. In non-consistent, spatially distant arrays, reliance on LTM is predicted to be higher for non-contextual contexts, leading to slower RTs when prompted for WM due to increased competition. Overall when prompted to search for LTM objects, faster RT measures are expected to be observed due to semantic binding of the context and memory encoding done.

Methods

Participants:

A pilot study on 4 people has been done, undergraduate students from Thapar University, Patiala. Matched on age and education level. Data sample of 50 people is expected to be taken for the main experimental study.

Procedure: There were three blocks of the experiment, and each block comprised three successive phases: A Training Phase, a Testing Phase, and a Search phase. For the Training phase there were 3 repetitions for each trial. In the Testing and Search phase there were 72 trials in total. Participants had to search for and choose the prompted object for the scene presented: old or new object. Then the visual search array could be of 3 types: consistent, inconsistent and only. They were represented with two visual search array screens in a series. For trials which began with Consistent visual search array, followed by the inconsistent search array was shown next and vice versa while Only search trials were done only once. The whole experiment took 35 mins to complete.

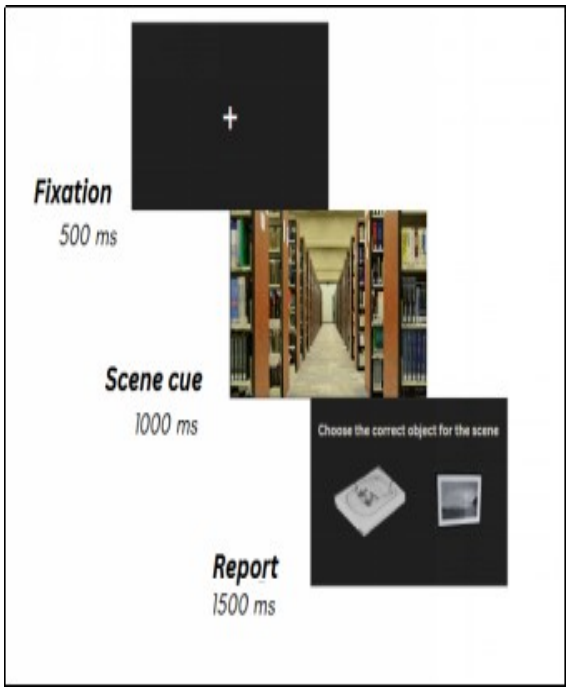

Fig 1.Training Phase

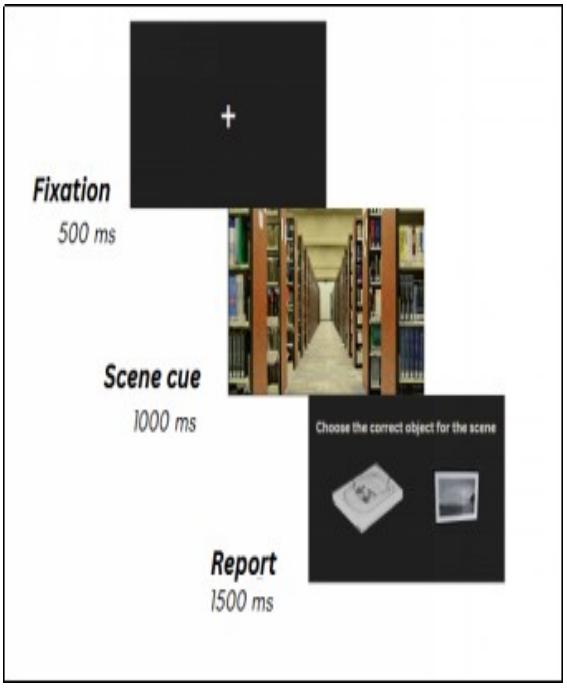

Fig 2. Testing Phase

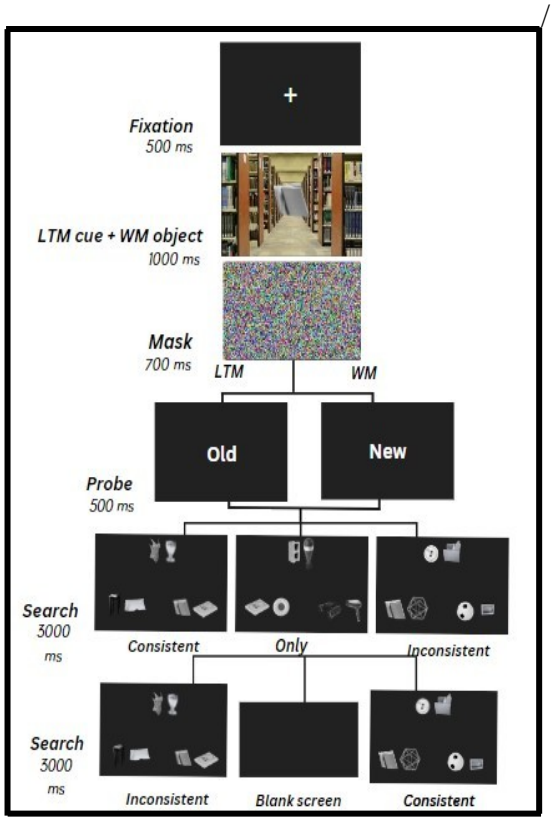

Fig 3. Search Phase

Study design: 2 (prompt type: Old versus New) x 2 (Context: Context present versus context absent) x 3 (Consistency type: Consistent, Inconsistent, Neutral) within subject design with a total 12 unique conditions.

Results

This is ongoing work and below are the pilot results from 4 participants showcasing mean differences between LTM and WM as a function of context presence or absence and visual search array consistency.

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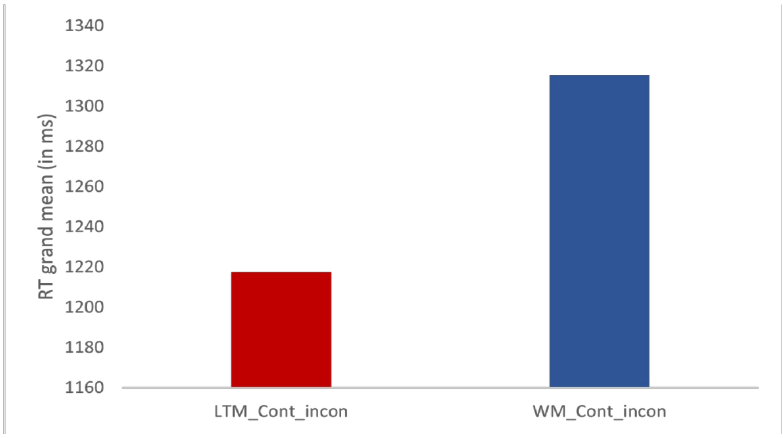

Fig 4. Plot for Grand mean of RT measure (in ms) of LTM-contextual-inconsistent trials vs WM-Contextual-inconsistent trials

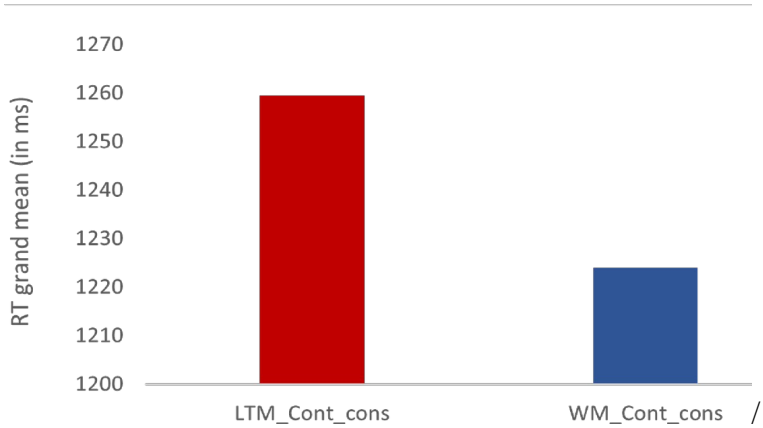

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Fig 5. Plot for Grand mean of RT measure (in ms) of LTM-contextual-consistent trials vs WM-Contextual-consistent trials

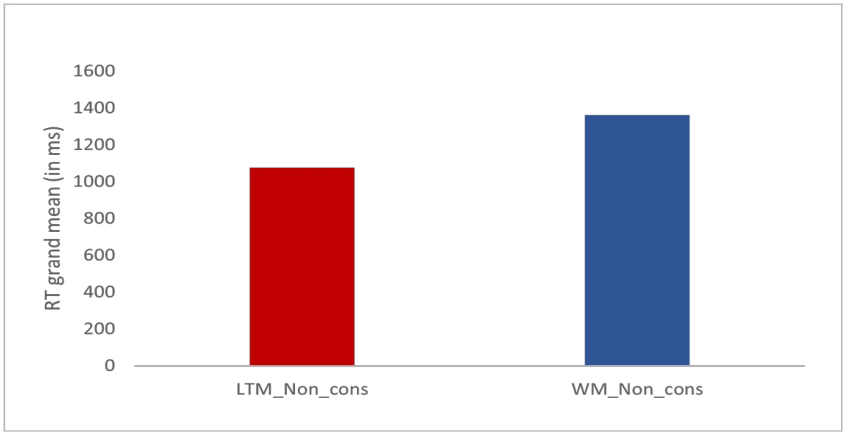

Fig 6. Plot for Grand mean of RT measure (in ms) of LTM-Non Contextual-consistent trials vs WM-Non Contextual-consistent trials

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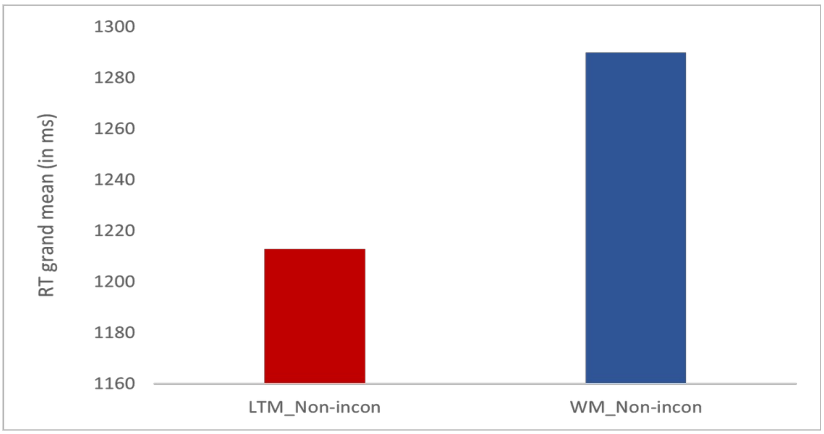

Fig 7. Plot for Grand mean of RT measure (in ms) of LTM-Non Contextual-consistent trials vs WM-Non Contextual-consistent trials

The results here show that explicitly in case of Contextual-consistent trials WM objects led to faster RTs compared to LTM objects. In other words, when there's a semantic association between the scene and object, and they are spatially close together there's attentional guidance to the space where WM object is present while prompted for LTM. As such, there's more interference due to the WM object being spatially close together. In contextual inconsistent, non-contextual-consistent and non-contextual-inconsistent search arrays, LTM objects were searched faster compared to WM objects showing clear preference for searching LTM objects in both inconsistent and inconsistent trials, especially when non-contextual pairings are presented.

This suggests that the LTM objects are easy to be guided despite the presence of WM objects being spatially close.

Discussion

There is clear comparison seen with better RT for LTM objects overall and better faster RT for WM objects when contextual consistent trials are performed. Reaction times (RTs) varied significantly based on prompt type and image context. The pilot data shows that potentially there could be a better effect seen between the type of prompt (LTM and WM encoded objects) and the same consistency type. Further data collection is still in progress to address study limitations like small sample size to see the clear effects of the semantic binding on the LTM and WM encoded objects depending on spatial location in the search array, with expectation to see the same effects with the bigger data.

Conclusion

Significant RT differences observed between old and new prompt trials within the same context, suggests a consistent effect of prompt type i.e. type of memory being probed with semantic context as WM showed especially better RT results in contextual-consistent trials leading to understanding that WM dominates over the old memory of an object in scenarios when both objects are close by and hold a semantic relation with the cue scene with in general better performance for LTM.

Heterogeneity in Loss Aversion Estimates across Modelling Approaches

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Introduction

Loss aversion, the tendency for individuals to weigh losses more heavily than equivalent gains, is a fundamental concept in behavioral economics and psychology. Typically explained by prospect theory (PT; Kahneman & Tversky, 1979), it states that decision-makers assign higher utility weights to losses rather than gains. Quantified by λ, it is usually estimated by fitting participants' choice data to PT (or its functional equivalents). Model choice also significantly affects explanatory power (Stott, 2006).

Recent meta-analyses (Brown et al., 2023; Walasek et al., 2024) show λ can vary substantially, highlighting the need for standardized measurement. While some variability has been attributed to factors, settings, and populations, the impact of estimation methodologies remains understudied. This exploratory study investigates how methodological choices influence λ estimation and assesses consistency across models.

Methods

We used four analytical approaches in this study—standard and advanced techniques of the field.

Generalized Linear Mixed Models (GLMM): Accounting for fixed and random effects. Following Tom et al. (2007), many studies use a GLM, where the ratio of loss and gain β coefficients computes λ.

Drift Diffusion Models (DDMs): These models estimate λ, while providing insights into cognitive processes underlying decision-making (Sheng et al., 2020; Zhao et al., 2020). The drift rate ν, depends on the gain and loss amounts weighted by their respective coefficients, which are then used to derive λ.

Maximum Likelihood Estimation (MLE): The dominant approach in the field uses the PT to conceptualize loss aversion. We fit choice data to two variants, one based on the constrained version where the gain and loss curvatures are same (α = β) and one where the parameters are unconstrained.

Hierarchical Bayesian Estimation: We fit PT to the data using hierarchical Bayesian analysis; allowing us to incorporate prior information and giving us a measure of uncertainty in our estimates.

To ensure that these estimation procedures can be run, we limited ourselves to studies that used sequential mixed binary equiprobable gambles. After an exhaustive search of databases, mailing lists, and studies with available data, we identified ten datasets (n = 686) from 7 studies (Khan & Mukherjee, 2023; Sheng et al., 2020; Sokol-Hessner et al., 2009, 2016; Sokol-Hessner, Hartley, et al., 2015; Sokol-Hessner, Lackovic, et al., 2015; Zhao et al., 2020). All analyses were run using R and Python.

Results

Our analysis reveals substantial variability in λ both within and across estimation methods. ML estimation: We find that the median estimates of the constrained model ranged from 0.995 to 1.801, while those based on the unconstrained range from 0.754 to 1.358.Simulated data fits showed slightly higher acceptance rates for the unconstrained model (.96 vs .98; p <

0.05). While this might reflect the number of parameters of the model, it also indicates the potential of model selection driving significant results.

Consistency across methods varied by dataset. For instance, Sheng et al. (2020) showed MLE λ of 1.35 [0.86, 1.84] and Bayesian λ of 1.55 [1.42, 1.69]. Established λ variability drivers, like stake magnitude (Mukherjee et al., 2017), were evident in relevant datasets.

Additionally, to understand broad differences, we conducted two random-effects meta-analyses: MLE and Hierarchical Bayesian methods. The ML meta-analysis yielded an overall estimate of 1.07 [1.01, 1.13], while the Bayesian meta-analysis pooled estimate is 1.25 [1.06, 1.47].

Importantly, our results are substantially lower than the original PT estimate of 2.25.

None of the intervals of λ include such high values, suggesting earlier overestimation.

Discussion

Our analysis provides insights into LA's nature and estimation. Theoretically, this variability suggests LA is not a fixed trait, but influenced by factors like experimental design, participant characteristics, and analytical approaches. Our results also emphasize that losses do not loom twice as large as gains, which has seemingly become a tautology (Mukherjee, 2019). Other substantive analyses that tackle these implications are being conceptualised.

This study demonstrates the complexity of measuring LA and the importance of methodological choices. While supporting the general concept of LA our results caution against over-generalization from single studies or methods. These findings call for a reevaluation of how loss aversion is conceptualized, measured, and applied in decision-making research.

Investigating the effect of Socio-economic Status (SES) on Brain Structural Integrity: A Diffusion Tensor Imaging (DTI) Study

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Introduction

An individual's socioeconomic status (SES) — including income, education, and occupation —reflects access to essential resources like healthcare and nutrition. Socioeconomic disadvantage, from early life through late adulthood, may lead to variability in brain health and its structural integrity, resulting in the early onset of age-related cognitive deficits (Shaked et al., 2022). Higher SES has been linked to better cognitive abilities and brain structure, while lower SES is associated with reduced cognitive and structural integrity, particularly in children and older adults (Chen et al., 2018; Dufford & Kim, 2017).

However, there's a lack of research on how SES affects brain health in middle-aged adults (ages 25-45), a period of relative brain stability before age-related cognitive decline. This stage, marked by significant life events like career and family responsibilities, highlights the importance of studying SES-related brain structure differences, especially in lower SES groups. A growing yet fragmented body of literature links SES with brain structural integrity, including brain microstructures such as white matter integrity (Shaked et al., 2022). White matter integrity is crucial for the effective transmission of signals between cortical regions. Healthy white matter ensures rapid and efficient signal transmission, essential for cognitive processes.

We utilized Diffusion Tensor Imaging (DTI) to evaluate white matter (WM) integrity by examining water molecule diffusion in WM tissues. We focused on fractional anisotropy (FA), a key DTI metric. Isotropy refers to equal diffusion in all directions, while anisotropy denotes preferential diffusion in specific directions. WM tracts exhibit limited water diffusion due to their directional organization. FA, which ranges from 0 to 1, measures the directionality of water diffusion, with higher values indicating better WM integrity and more effective signal transmission across the brain.

Studies have linked different white matter tracts to cognitive functions (executive functioning)—the genu, body and splenium of corpus callosum (GCC, BCC, and SCC), the superior longitudinal fasciculus (SLF), anterior limb of the internal capsule (ALIC), cingulum bundle (CGB) at cingulate and hippocampus and external capsule (EC) (Noble et al., 2013). In this study, we also examined bilateral tract-specific WM integrity (FA values) in these 13 key tracts associated with cognitive processes.

While lower SES has been typically associated with less-developed brain macrostructures, studies of microstructural integrity are largely unexplored, especially in South Asian populations. In India, SES is shaped by diverse factors beyond income, such as family size, neighbourhood, and caste. Despite these complexities, no neuroimaging studies have examined white matter integrity in Indian populations. This study aims to explore whether white matter integrity in young and middle-aged Indians differs in lower and higher SES backgrounds as a marker of neural connectivity within white matter and cognitive processes where we hypothesize that higher SES is linked with higher FA and vice-versa.

Method

- Participants: Sixteen individuals from diverse social and occupational backgrounds were recruited, with eight in each lower and higher SES group. For lower SES, Mean

age = 35 ± 5.63 years (7M, 1F) and for higher SES, Mean age = 32 ± 3.05 years (7M, 1F).

- Assessment of poverty: SES was assessed using the modified Kuppuswamy scale, 2023 (Shifana & Rameez, 2023), with participants categorized into lower SES (Mean score =
  8.62) and higher SES (Mean score = 27.25) groups based on their scores.
- Structural-MRI data acquisition protocols: Diffusion-weighted images were acquired on a 3T fMRI using a single-shot echo-planar sequence with 2x2x2 mm resolution. Parameters: TE = 85 ms, TR = 9000 ms, FOV = 220 mm, 65 slices, 32 directions, and a b-value of 1000 s/mm².

Results

Whole-brain analyses: The lower SES group had a mean FA value of 0.258 (SD = 0.0098) with a narrow range (0.248-0.276), while the higher SES group had a mean FA value of 0.259 (SD = 0.0104) with a slightly wider range (0.239-0.274) . T-test showed no significant difference in FA scores between the groups (p=0.876), indicating that any differences are likely due to chance.

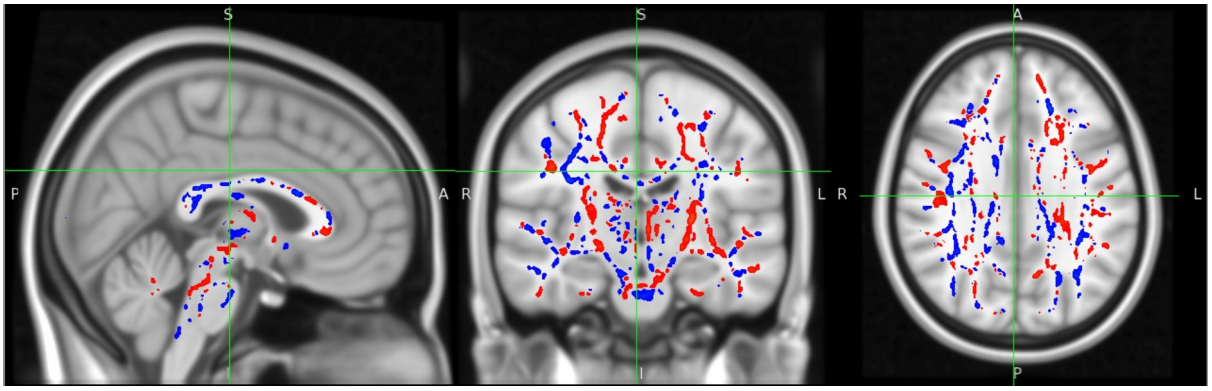

Fig 1: TBSS uncorrected p-values: Tract-based Spatial Statistics (TBSS) where T-maps show a) blue for low > high and b) red for high > low, with a minimum display range of 0.2. (Smith et al., 2006).

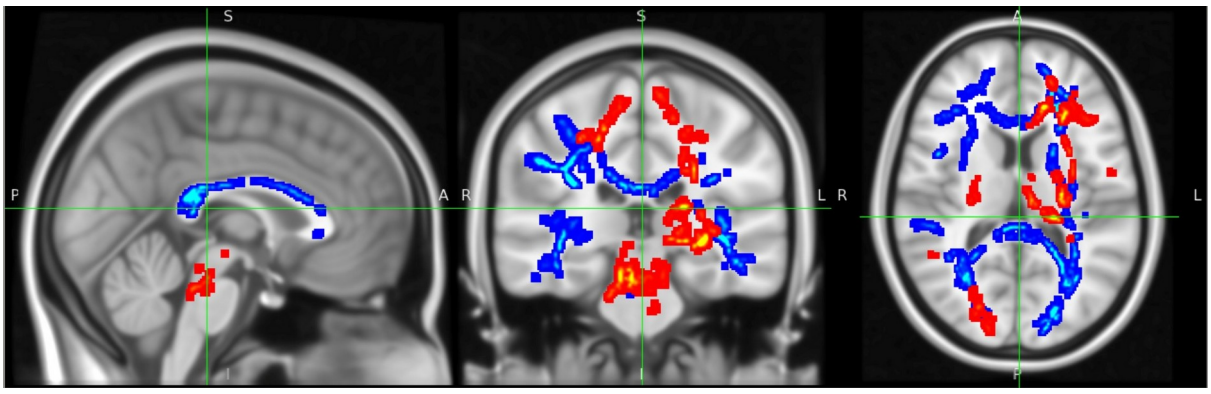

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Fig 2: Cluster FA maps displaying the corrected p-values, a) blue for low > high and b) red for high > low. Display range is set to 0–0.1 (adjust to 0.949–1 to visualize significant differences) Smith & Nichols, 2009).

Tract-based analyses: While assessing tract-specific white matter integrity across 13 cognitive-related tracts, correlations between SES scores and FA values ranged from -0.4 (SCC) to 0.09 (EC-Right), showing weak to moderate linear relationships, none of which were statistically significant ($p>0.05$). T-tests comparing FA values between higher and lower SES groups showed no significant differences after Bonferroni correction, with all corrected p-values remaining above 0.05.

Discussion

The results did not support our hypothesis of significant correlations between SES and FA across both SES groups. However, we observed a moderate, but non-significant, negative correlation between SES and FA in the splenium of the corpus callosum. Most tracts in our findings exhibited an inverse FA-SES relationship (non-significant). A potential explanation for this could be chronic stress from high-pressure urban environments adversely affecting the brain's structural integrity in the higher SES groups. In contrast, the right external capsule showed a weaker positive correlation between SES and FA. The external capsule connects the cerebral cortex with subcortical structures and is involved in motor and sensory processing, aligning with early-life myelination and stability (Gao et al., 2009). This might contribute to the observed positive FA-SES relationship, as higher SES could correlate with better health and environmental conditions that support optimal maintenance of these pathways and may be less influenced by the cognitive and emotional stressors linked to lower SES as they develop.

The findings align with a previous study (Jednorog et al., 2012) that also found no significant SES-FA correlations in children and young adults. While a larger sample size might be needed to detect differences, investigating microstructural integrity during early to middle adulthood (ages 25-45) is crucial for establishing a baseline and understanding potential future age-related cognitive decline.

Human-Robot Interaction in Economic Decision-Making: Insights from Dictator Games

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IIT Delhi, Leiden University

Introduction

Robots, with their diverse and fascinating morphologies, have long captivated the human imagination. Their appearances vary widely from sleek, humanoid machines to industrious, utilitarian designs and, accordingly, elicit a range of perceptions from people. This variability presents unique opportunities to investigate human social interaction with robots, particularly in experimental contexts such as behavioral decision-making tasks. The dictator game (DG), a powerful tool for investigating social preferences and norm adherence in economic decision-making, provides an ideal framework for this exploration. In these games, one player (the dictator) unilaterally decides how to split an endowment with another player (the recipient), who must accept any offer made. Traditional economic theory, based on assumptions of rational self-interest, predicts that dictators should keep the entire endowment. However, decades of research with human participants have consistently shown that dictators often share a significant portion, a behavior attributed to social norms of fairness and altruism (Engel, 2011).

This study explores the potential factors driving human-robot interaction within the context of economic decision-making, specifically using the dictator game paradigm. While DGs have been extensively employed in human-human interactions, their application to human-robot scenarios remains underexplored, and we have yet to understand the cognitive mechanisms that drive our interactions with non-human agents like robots (Cross & Ramsey, 2021). Previous studies have demonstrated that humans are willing to allocate money to robots in economic games (e.g., de Kleijn et al., 2019), raising intriguing questions about what drives such behavior. Various explanations have been proposed for this phenomenon, including anthropomorphism (Epley et al., 2007), the perceived functionality of robots (Onnasch & Roesler, 2019), and the influence of experimental paradigms. However, we suggest that specific characteristics of the robots, specifically those related to their likeability, may play a crucial role in shaping prosocial behavior towards them.

Our research investigates whether participants would offer money to a robot opponent within a dictator game framework and aims to elucidate the moderators of this prosocial behavior. We examine whether such behavior stems from general prosocial inclinations, specific cognitive representations of robots, or artifacts of experimental design.

Method

We conducted four online, multisite experiments (N = 426) designed on Qualtrics. The sample consisted of participants from India and the Netherlands, and all participants were first required to indicate their location. The primary experimental paradigm involved two key components:

- *Robot Perception Items*: Participants were presented with 18 robots, chosen from the IEEE website, with varying morphology and levels of anthropomorphism. They responded to 12 questions assessing their cognitive representations of each robot. These items ranged from the perceived likeability to intentionality to the social functionality of the robots.
- *Dictator Game*: Following the perception items, participants played one round of the dictator game with each robot. The dictator game amount was €10 for participants

from the Netherlands and ₹250 for those from India across all studies. We systematically manipulated game characteristics across studies:

- Study 1 (N = 212): Counterbalanced order of perception task and dictator game
- Study 2 (N = 84): Standard dictator game with hypothetical money
- Study 3 (N = 64): Standard dictator game with real money
- Study 4 (N = 66): Two-step dictator game with real money, introducing an explicit choice to reject making offers

Results

To understand the underlying data structure, we conducted a Principal Components Analysis of the perception data, which supported the retention of three factors - likeability, anthropomorphism, and social functionality. These factors align with distinct representations of robots, potentially reflecting aspects of social cognition engaged in human-robot interaction.

Linear mixed effects analyses revealed that all three factors independently predict offers in dictator games (all ps < .05). Interestingly, likeability emerged as a stronger predictor of offers compared to anthropomorphism, suggesting that anthropomorphism alone is insufficient in explaining prosocial behavior toward robots. This finding implies that likeability judgments may be more significant in driving prosocial behavior than previously thought.

Our results also demonstrate the impact of varying the experimental paradigm on decision-making processes. Participants offered significantly lower proportions when playing for real money compared to hypothetical scenarios [$t(146) = 2.65$, $p = .009$, $d = 0.44$], indicating how the mental representation of stakes might influence prosocial behavior. Moreover, the two-step DG yielded substantially lower offers than the one-step version [$t(128) = 4.31$, $p < .001$, $d = 0.76$], suggesting that explicit framing of the choice to give or not give may activate different processes or decision strategies.

Notably, the same pattern of results was observed in participants from both India and the Netherlands, suggesting cross-cultural consistency in the mechanisms underlying human-robot interaction in the present case.

Discussion

This research highlights the interplay between the perception of robots and how these representations influence prosocial behavior toward these agents. The fact that participants consistently offered money to robots, despite their inability to use or benefit from it, suggests that more "automatic" socio-cognitive processes may be activated in human-robot interactions. These results may also lend support to frameworks like Computers are Social Actors (CASA), which attempt to explain our "mindless" behavior toward non-human agents. Furthermore, the differences in offers with money type shed light on how contextual factors can modulate our behavior. The observed differences in offers in a one-step versus two-step game align with dual-process theories of cognition, suggesting that different decision frameworks may engage distinct cognitive systems or strategies.

The findings from these studies contribute to our understanding of human-robot interaction in economic decision-making contexts. It also provides practical implications for the design of social robots, suggesting that enhancing perceived likeability may be more effective than making robots more human-like in fostering positive human-robot interactions.

LLMs and Ethical Dilemmas: Would AI push you off a boat to save five people?

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Introduction

As large language models (LLMs) are increasingly used for decision-making and advice, understanding their moral landscape is crucial. Unlike human moral reasoning, which can be traced to a variety of cognitive, social, and affective factors, LLMs' responses are based only on the vast amounts of ingested data. The models are also susceptible to errors such as "hallucinations" while remaining confident in their response. Additionally, a recent study has shown that people underestimate and are easily swayed by the strength of the advice from ChatGPT when confronted with moral dilemmas (Krügel et al., 2023). Responses by LLMs are also often publicly scrutinized, requiring interventions by the makers aiming for noncontroversiality (Heath, 2024).

These circumstances necessitate a systematic approach to understanding LLM decision making. One way to understand LLMs is to apply similar psychological methods as we do to humans (Hagendorff et al., 2023). In this study, we aim to investigate the extent to which LLMs simulate human moral reasoning and how different models compare.

Methods

This study compares the moral decisions of human participants to those of multiple LLM agents. We use a boat variant of the classic trolley dilemma where the respondent has to decide whether to push a passenger off a boat to save five drowning swimmers. This version maintains the essence of the trolley problem and is not widespread, making it less likely to be included in the training data of the models. The human choices (N = 1303) are taken from a large cross-cultural study (Bago et al., 2022) that sought to extend Greene et al. (2009). We used data from a single item throughout this study.

For the LLMs, we used all variants of Claude 3—Haiku, Sonnet, Opus, and Claude 3.5 Sonnet. These models are listed from least to most advanced. To ensure consistency and reliability, the LLMs were queried programmatically using an API with near-identical prompts of the survey item. The temperature setting, which controls the randomness of LLM outputs, was left at default values to reflect typical use conditions. Since there was randomness in the responses, we sent a large number of requests (250-500) to each of the models. Each prompt of the item is a fresh run for the LLM, helping it maintain independence from its previous response. This would be equivalent to starting a new conversation for each prompt in a web interface.

The analysis at this preliminary stage of the study was relatively simple, involving the proportion of acceptances. Human responses served as the baseline for the comparative analysis, specifically the "YES" responses, which indicate a utilitarian moral judgment—opting to save a greater number of people at the expense of sacrificing one life.

Results

Our findings reveal significant differences between human and LLM decision patterns, as well as variations among different versions of Claude. Human participants chose the utilitarian option (responding "YES") 34.8% of the time, indicating a willingness to push a passenger off a boat to save five drowning people. In contrast, the LLMs showed a wide range of responses:

1. Claude 3 Haiku: 67.6% "YES" responses

2. Claude 3 Sonnet: 0.8% “YES” responses
3. Claude 3 Opus: 11.2% “YES” responses
4. Claude 3.5 Sonnet: 13% “YES” responses

Chi-square tests (all ps < 0.001) found significant differences between the choices of human participants and each model. Haiku, the earliest of this family, is significantly more utilitarian than the human participants. More advanced LLMs (Sonnet and Opus) tend to be more “conservative” in their moral judgments than humans and Haiku. Notably, the most advanced model, Claude 3.5 Sonnet, showed a slight increase in utilitarian responses compared to its predecessor, potentially indicating a trend towards more nuanced human-like decisionmaking. While imperfect, it may be inevitable that these models would be tailored to be more human-like in their morality.

Discussion

This preliminary study highlights the significant variability in moral reasoning among different AI models and the stark, albeit shrinking, contrast between AI and human moral judgments. Earlier models like Haiku are more likely to choose the utilitarian option, suggesting a prioritization of outcomes over ethical complexities. In contrast, the advanced versions lean towards conservatism, potentially reflecting developers’ attempts to align LLM outputs with more traditional ethical standards or to avoid controversial decisions, thus allowing a glimpse into the continuing refinement process of LLMs.

These findings are preliminary, and much more work is needed in this area. While some of the models’ response rates may be similar to those of humans, it is not appropriate to assume similar underlying processes to those of humans. Further research is in progress— expanding from one dilemma to using a diverse set of dilemmas and expanding the family of models that is needed to fully understand the decision-making patterns of LLMs and their alignment with human reasoning. Additionally, while there is a growing alignment between LLM and humans, the question remains: which humans are those (Atari et al., 2023)? These findings have important implications for building AI systems in contexts involving ethical decision-making and in using those systems.

Effect of Individualized taVNS on Motor Cortical Excitability: A Paired-Pulse TMS Study

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IIT Gandhinagar, National Institute of Mental Health and Neurosciences Bengaluru

Introduction

Transcutaneous auricular vagus nerve stimulation (taVNS) is a non-invasive technique targeting the auricular branch of the vagus nerve (ABVN) using surface electrodes. While traditional VNS involves surgical implantation, taVNS is a safer and more accessible alternative. One growing area of interest is its impact on motor cortical excitability, crucial for motor control and neuroplasticity. Meanwhile, paired-pulse transcranial magnetic stimulation (TMS) is a technique that administers two consecutive pulses to the primary motor cortex. It serves as a tool to assess cortical excitability, focusing on intracortical inhibitory and facilitatory processes. This study studies the impact of taVNS on motor cortical excitability in healthy adults using TMS. Despite promising outcomes in previous studies, critical questions about the optimal use of taVNS and understanding its underlying mechanisms still need to be answered. For instance, studies of Capone et al. (2015) and van Midden et al. (2024) obtained significant results, but unclear stimulation parameters and variable sham control protocols have limited their findings. Our study uses a passive control for sham sessions and an individualized marginal threshold for taVNS to address these limitations to ensure blinding and optimal stimulation intensity. In this study, we primarily assess the Motor Evoked Potentials (MEPs), Short Interval Intracortical Inhibition (SICI), and Intracortical Facilitation (ICF). Secondary outcomes include Resting Motor Threshold (RMT) and Long Interval Intracortical Inhibition (LICI).

Methods

The study involved healthy adults aged 18-45 (n = 10, mean age = 24.22, SD = 4.52), screened for eligibility based on medical history and vital signs (Capone et al., 2015; Mertens et al., 2022). After obtaining informed consent, the participants underwent two sessions, one with active taVNS and one sham, in a randomized, single-blinded design. The taVNS protocol included a titration phase to determine individual tolerance for the stimulation parameter, rated as a three (3) on a 0-5 scale by the participant after randomized titration. Next, we administered TMS by placing the electrodes on the contralateral hand's first dorsal interosseous (FDI) muscle. We determined the RMT, obtained the MEP, and then delivered paired-pulse TMS to measure SICI, LICI and ICF. Then, we administered 30 minutes of intermittent taVNS at the tragus (100 Hz frequency, 250 microseconds pulse width) at a marginal threshold intensity (Günter et al., 2019). Finally, we administered TMS again to measure the cortical excitability post-taVNS. Participants' vitals were monitored pre- and post-procedure to ensure their safety before discharge. We followed the same protocol for the sham session with passive stimulation on the tragus.

Result

We performed repeated measures of two-way ANOVA and found that SICI, MEP and RMT varied significantly in active sessions. SICI revealed a significant Set effect ($F(1, 8) = 39.914$, $p = 0.0002$, $\eta^2p = 0.221$) and a significant Session × Set interaction ($F(1, 8) = 27.827$, $p = 0.0008$, $\eta^2p = 0.186$). For MEP Amplitude, significant effects were found for both Session ($F(1, 8) = 9.576$, $p = 0.015$, $\eta^2p = 0.5448$) and Set ($F(1, 8) = 10.378$, $p = 0.012$, $\eta^2p = 0.5647$), with a strong interaction effect ($F(1, 8) = 10.492$, $p = 0.012$, $\eta^2p = 0.5674$). RMT also showed a significant Session effect ($F(1, 24) = 17.544$, $p = 0.0003$, $\eta^2p = 0.4223$) and

Set effect ($F(1, 24) = 12.923$, $p = 0.0015$, $\eta^2p = 0.3500$), with a moderate interaction ($F(1, 24) = 4.211$, $p = 0.0512$, $\eta^2p = 0.1493$). Post hoc analysis indicated that active post-measures were significantly higher for MEP Amplitude (mean difference = 1.27, $p = 0.0014$) and significantly lower for SICI (mean difference = -61.54, $p = 0.0007$) and RMT (mean difference = -2.78, $p = 0.0218$) compared to active pre-measures. None of the sham measures had any significant differences.

Discussion

The results of our study show that taVNS effectively modulates motor cortical excitability by increasing MEP amplitude and reducing SICI. They suggest that taVNS may enhance neuroplasticity by modulating inhibitory circuits within the motor cortex. The reduction in SICI indicates decreased inhibitory control, possibly due to taVNS affecting GABAergic activity or altering the thresholds for activating intracortical inhibitory circuits. This reduction may facilitate greater cortical responsiveness, contributing to the increased MEP amplitude observed. Similarly, the reduction in RMT implies a decreased threshold for motor cortex activation, which could indicate enhanced motor cortical excitability. Moreover, the lack of significant differences in ICF is consistent with the literature (Sara et al., 2024). It could be due to the stimulation parameters used in this study, such as frequency, intensity, or duration, which may not have been optimal for modulating excitatory circuits. ICF has greater variability than SICI, making it harder to detect subtle changes, especially in a short duration. The lack of significant findings in measures of LICI could also be due to the duration of taVNS being insufficient to induce lasting changes in LICI or because the neural circuits involved in LICI are less responsive to the type of stimulation provided. Future research should explore these longer intervention durations to fully understand the scope of taVNS effects and their therapeutic potential in neurorehabilitation.

Effect of Contemplative Debate Practice (from Gelug Tradition) on Emotion Regulation and Experience

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Most of the research on contemplative practices so far has focused on mindfulness meditation [1], loving-kindness meditation [2], and yoga [3]. We recently started to investigate the effects of a different contemplative practice—Tibetan monastic debate. Monastic debate is a practice in which the practitioner tries to improve their embodied understanding of Buddhist philosophy by going through a precisely-described process of reasoning in interaction with one or more others [4]. The goal of the practice is for one participant, the defender, to maintain a consistent position, while the other participant, the challenger, tries to find ways to undermine this consistency. In addition to using clever arguments to undermine consistency, monastics are encouraged by their teachers to tease each other and distract each other from their arguments. This encourages the monastics to develop strategies to maintain their cool to avoid getting angry or upset and thereby lose the ability to reason clearly. This phenomenology of debate suggests that debate itself is a method that improves emotion regulation. We set out to examine that claim in the current study.

To test whether monastic debate improves emotion regulation, we conducted two experiments. Emotion regulation was measured with the Difficulty in Emotion Regulation Scale (DERS) and the emotional experience with the Positive and Negative Affect Schedule (PANAS). In the first crosssectional experiment, we recruited 66 monks and 145 control participants (73 from Lay Tibetan community and 72 from the university). The ratings from the monks were compared to control groups of the Lay Tibetan community and Indian university students, to equalize culture and education level, respectively. In the second experiment, we looked at novice practitioners before and after they participated in a month-long debate winter school. Measurements were obtained twice from the control group without any intervention. For this longitudinal experiment, 40 participants were recruited from a Debate Winter School and compared with 63 participants in the control group.

We performed LME analysis for both the experiments. Results from the first experiment show that the Tibetan monastics did not differ in terms of their affective states as well as emotion regulation. The lack of significant effect surprised us, especially given that in our interactions, the monks seemed to really exude significant positive affect and exhibit few problems in emotion regulation. A possible explanation for these results is cultural differences in the interpretation of the scale items and the anchoring of the judgments. For example, we found that monastics implicitly anchored their judgments to the Buddha at the top end of the scale. In addition, emotions that are considered positive affect in the scales, e.g., pride, are in fact considered negative affect in the Tibetan monastic community. This interpretation of the results is bolstered by the findings from the longitudinal study, in which the novice practitioners reported increased positive affect compared to controls. Both groups reported an increase in positive affect during the second measurement compared to the first. The negative affect did not show any significant effects although there was a trend of reduced negative affect post training for novice practitioners. More importantly, the novice practitioners showed better emotion regulation post-training. However, the controls did not differ in terms of emotion regulation between the two measurements. These results are similar to those observed in mindfulness training [5, 6].

Future research should further validate these findings by developing better instruments to measure emotion regulation that can add to self-report, e.g., the use of automatic reactions to images or videos. If such studies validate the findings, that will open up the possibility for using these practices to enrich the repertoire of contemplative practices. These practices may be particularly suited to individuals who prefer logical thinking and reasoning over faith and simple experiencing, and they may also be particularly suited to very active individuals who have trouble sitting still.

The Hindi Lexicon Project: Lexical decision data for 11500 Hindi words

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Introduction

Understanding how Hindi speakers process written words is crucial for developing more effective educational tools and cognitive models. The Hindi Lexicon Project is an innovative research initiative aimed at mapping the cognitive processing of Hindi words through reaction time studies, providing foundational data for psycholinguistic research in Hindi. This abstract outline the methodology, findings, and implications of this ongoing extensive study.

Participant: We recruited 31 participants (ongoing), all of whom were native Hindi speakers with normal or corrected-to-normal vision. The participants were aged between 21 and 39 years (M = 25.24, SD = 5.62) and rated their proficiency in Hindi on a 5-point scale, with a mean score of 3.55 (SD = 0.67).

Method

Stimuli consisted of 11500 words selected from Shabd corpus (https://link.springer.com/article/10.3758/s13428-021-01625-2) , divided in 46 blocks drawn from a Hindi psycholinguistic corpus called Shabd. Additionally, 11500 non-words were created by single substitution method. Participants responded by pressing 'm' for words and 'z' for non-words.

Result

Analysis was carried out only on data of 21 participants out of 31. 10 participants were removed due to partial and inconsistent data across various blocks. Validation of the collected data was done by testing effects of following factors. Significant effects of Word Frequency ($F(1,11222) = 1587.23$, $p < 0.001$), Contextual Diversity ($F(434, 10789) = 4.56$, $p < 0.001$), Akshar Count ($F(1, 11222) = 4015.46$, $p < 0.001$), Maatraa Count ($F(1, 11222) = 304.98$, $p < 0.001$), Total Length ($F(1, 11222) = 2519.53$, $p < 0.001$), Syllable Count ($F(1, 11200) = 2567.35$, $p < 0.001$), Phoneme Count ($F(1, 11200) = 3201.46$, $p < 0.001$) and Neighbourhood Density ($F(1, 11222) = 3494.09$, $p < 0.001$) were found on mean reaction time.

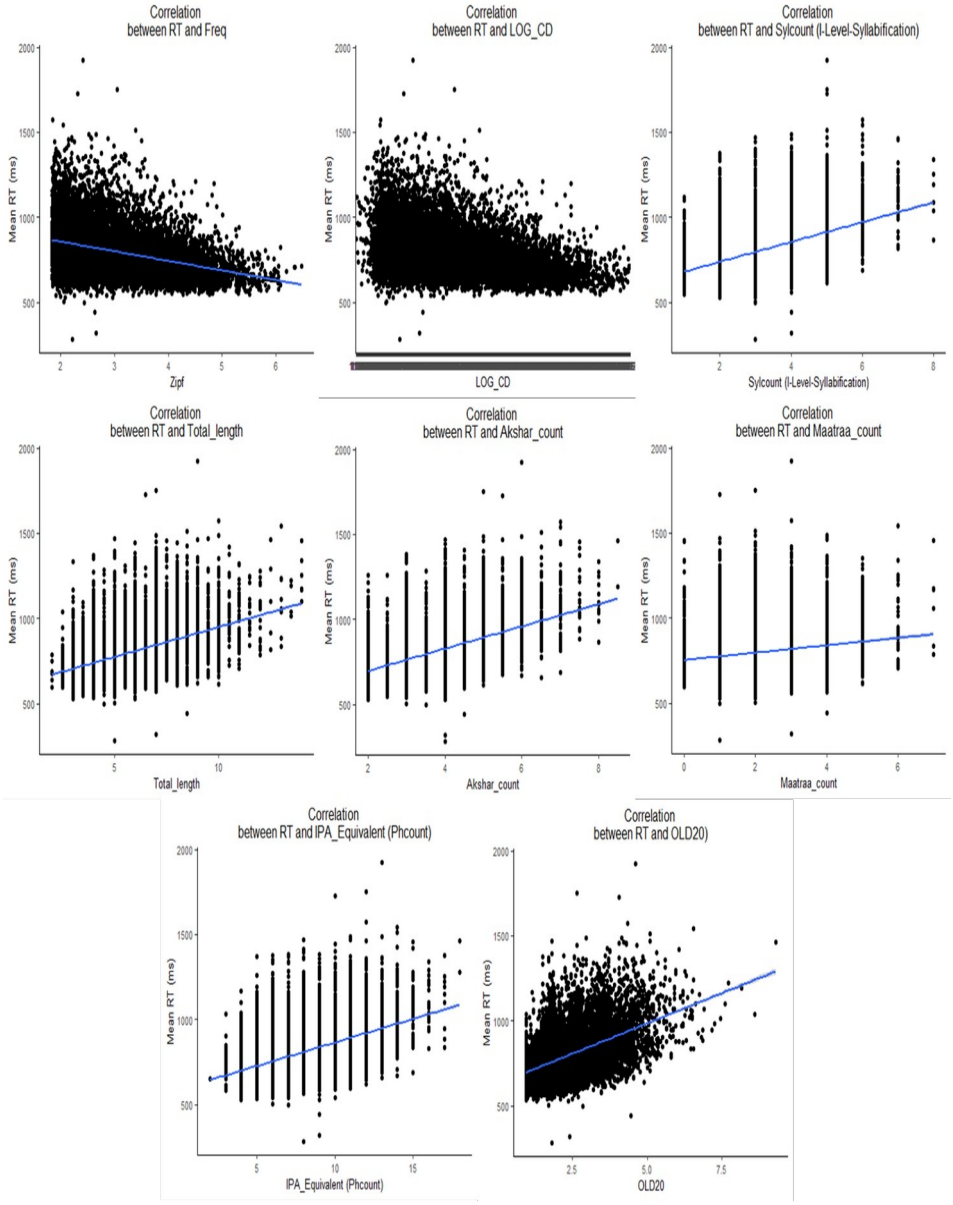
Word Frequency, Contextual Diversity, Akshar Count, Maatraa Count, Total Length, Syllable Count, Phoneme Count and Neighbourhood Density were found to be accountable for 12.4%, 15.5%, 26.4%, 2.7%, 18.3%, 18.7%, 22.2% and 23.7% respectively of variance of meant RT. Since, the data collection is still ongoing, complete data will give better insights.

Discussion

This project contributes to the broader understanding of visual word recognition in non-Western languages, providing empirical data that challenge and extend existing cognitive models primarily developed through research on Indo-European languages like English, Dutch, French etc. Our future work will focus on extending this dataset with eyetracking measures to examine the fine-grained temporal dynamics of Hindi word recognition, and applying machine learning techniques to predict reaction times based on linguistic features.

Sample stimuli:
Words: रचाया, नौकरशाह, सुनार, कारीगर
Non-words: संशमी, सराावसान, नूफ, सुचेगी

Figures:



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Additional information about Hindi Language:
Hindi differs from other languages in terms of how syllables and vowels are defined in the language. Consonants in the language have hidden vowels at their end, also called as schwa, for example, क /ka/ is just akshara in Hindi but can be considered as a whole syllable in some cases. However, in most cases, diacritic markers i.e. vowels are added to such aksharas or consonants to add to its phonology. Such markers are called matras and can be added to the aksharas in both linear and non-linear fashion, example (क+ा

= का /kaa/ and क+ि = कि /ki/). Such markers (matras) can also be written to top or bottom of the consonant (akshara), each changing the pronunciation in different ways. Thus, we defined sub syllabic unit in Hindi as a combination of akshara (consonant) + matra (diacritic marker or vowel). (if matra is present), or just akshara (consonant) (if matra is absent).

Exploring Functional Neurological Overlaps in Adults with ADHD and Schizophrenia: An fMRI Study Using Deep Learning Model

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CHRIST University, PES university

Introduction

This study aims to explore the neurological and functional overlaps in adults with attentional deficit hyperactivity disorder (ADHD) and schizophrenia (SZ), focusing on both cognitive tasks and resting-state conditions. While both disorders share symptoms like cognitive deficits including impairments in attention, working memory, executive function and impulsivity, they also have distinct differences in symptom expression and brain function. Although individual cognitive domains and specific brain regions have been extensively studied, the interplay between neural activity in cortical and subcortical regions during task-based activations—such as task-switching and executive control—remains under-explored (Pan & Wang, 2023). This study addresses the gap by comparing resting-state functional connectivity (FC) patterns and task-based activations in critical brain regions associated with ADHD and SZ. It uses functional magnetic resonance imaging (fMRI) and deep learning (DL) algorithms to examine how common neural pathways overlap between these disorders. It aims to provide insights into the disrupted communication within large-scale brain networks in ADHD and SZ. This approach provides a more comprehensive understanding of their neurobiological underpinnings and contributes to the field by clarifying the overlapping and divergent neural mechanisms involved.

Methods

The study utilised the University of California, Los Angeles Consortium for Neuropsychiatric Phenomics dataset, comprising resting-state functional magnetic resonance imaging (rs-fMRI) and task-based fMRI data. A balanced subset of 60 healthy controls, 49 individuals with SZ, and 40 individuals with ADHD, aged 21-50 years, was selected. Data was acquired following the Declaration of Helsinki, with written informed consent obtained under UCLA Institutional Review Board approval. The fMRI protocol included a 304-second resting-state session, a stop-signal task, and a task-switching task. An ML pipeline was applied to the fMRI data, beginning with preprocessing and dimensionality reduction using Principal Component Analysis (PCA) to manage the high-dimensional fMRI data. Multiple classifiers were tested, with the Gradient Boosting Classifier achieving the highest accuracy among the ML models. However, to substantially improve the accuracy we used a DL approach using a 3D Convolutional Neural Network (CNN) approach, which outperformed the traditional models.

With this, we identified brain regions with common and distinct activation patterns across the disorders. FC within these regions was examined, and connectivity matrices were compared between groups. Statistical analyses, including difference matrices and t-tests, identified significant differences in connectivity patterns.

Results

Our model achieved an accuracy score of 63%, with a precision of 0.68, recall of 0.64, and an F1 score of 0.66 in distinguishing between ADHD and SZ using a 70-30 train-test split. The

3d-CNN model achieved an Accuracy score of 81%, with a Precision of 0.84 Recall of 0.82 and an F1 Score of 0.86. The area under the curve (AUC) was 0.86, indicating a moderate ability to differentiate between the two disorders.

In the resting state, the ADHD group exhibits heightened activation in the Superior Frontal Gyrus (735.81), Middle Frontal Gyrus (713.32), Postcentral Gyrus (718.28), and Superior Parietal Lobule (682.15), suggesting hyperactivity or compensatory mechanisms. The SZ group shows balanced activation, with increased activity in auditory regions, such as Heschl's Gyrus (780.63) and Planum Polare (652.23), while the control group demonstrates moderate activation across most areas, including the Frontal Pole (601.73). During the stop signal task, the ADHD group shows heightened activation in the Superior Frontal Gyrus (796.21) and Postcentral Gyrus (753.96), indicating increased cognitive control effort. The SZ group remains highly active in auditory regions, and the control group maintains moderate activation. In the task-switching task, ADHD participants exhibit heightened activation in frontal and parietal regions, while the SZ group shows reduced activity in sensory areas. The control group serves as a consistent baseline with moderate activation across tasks.

In both disorders, the Insular Cortex shows consistently higher activation across tasks. In comparison, both exhibit lower activation in the Lateral Occipital Cortex (ADHD: 187.67, SZ: 76.99) and Temporal Pole (ADHD: 156.37, SZ: 393.67) during task-switching.

FC analysis revealed weaker Juxtapositional Lobule Cortex-Frontal Pole ($t = -2.9222$, $p = 0.0095$) and stronger Intra Calcarine Cortex-Superior Frontal Gyrus ($t = 2.6513$, $p = 0.0168$) connectivity in ADHD and SZ. During task-switching weaker connections included Frontal Orbital-Inferior Frontal Gyrus ($t = -2.9166$, $p = 0.0096$) and Precentral-Juxtapositional Lobule Cortex ($t = -2.4007$, $p = 0.0281$), with enhanced Superior Frontal Gyrus-Intra Calcarine connectivity ($t = 3.1399$, $p = 0.0059$).

Discussion

The results of this study demonstrate notable overlaps in brain activity between ADHD and SZ, supporting the hypothesis that these disorders share common neurobiological foundations. Both disorders showed similar activation patterns in key brain regions, such as the temporal pole, insular cortex and lateral occipital cortex, across various tasks and at rest. This finding suggests that ADHD and SZ may affect the same brain networks involved in complex cognitive processing despite their differing symptoms. The DL model's accuracy in identifying these overlaps highlights its potential utility in enhancing our understanding of these conditions. However, the study also found task-specific differences in brain activation, indicating that while some neural mechanisms are shared, the specific cognitive demands of each task result in distinct activation patterns for each disorder.

Future studies can enhance the accuracy of the DL model by considering a diverse sample, enhancing the generalisability of the obtained results. Integrating multimodal neuroimaging data and applying transfer learning techniques could help improve model generalizability. PCA can also obscure important signals if not carefully applied, leading to the loss of valuable information or misinterpreting neural patterns.

Neural Entrainment to Consonant and Dissonant Musical Stimuli: An EEG Study

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Introduction

Electroencephalography techniques have been used widely to decode auditory processing in humans. Unlike speech, which relies on rapidly changing broadband sounds, music relies more on slower and more precise changes in frequency (Zattore et al., 2002). Frequency-following responses (FFRs) reflect the brain's ability to synchronize neural oscillations with the frequency components of an external stimulus (Kraus et al., 2017).

Harmony, as a fundamental music component, embodies the interplay between consonance and dissonance. A tone with a simpler frequency ratio is said to be a consonant, i.e., it is more pleasant for the user's perception. In contrast, tones with complex frequency ratios are said to be of a dissonant nature, having an unpleasant listening experience. Previous research found a "robust" brainstem response with strong correlation between the neural and behavioral preferences towards musical stimuli with consonant stimuli (Bidelman and Krishnan, 2009).

The present study investigates neural entrainment using FFR responses to two different types of musical stimuli: dyads and triads. A dyad is simply two notes played together, forming an interval but not a full chord. In contrast, a triad is a three-note chord that forms the basic building block of harmony in music.

Methods

The experiment was carried out in two blocks: the behavioral and the neural block. For the experiment, 8 dyad and 21 triad stimuli were selected. The primary frequency was fixed to be C4. The range of the secondary frequencies varied from C#4 to C5. The classification of tones as consonants or dissonants based on music theory was further verified by mathematically modeling the frequencies for parameters such as harmonicity and roughness. Roughness is an unpleasant sensation caused by interactions between spectral components in the inner ear. Harmonicity refers to the degree to which a sound resembles a harmonic series, i.e., a set of frequencies that are integer multiples of a fundamental frequency, which is perceived as pleasant and consonant.

Wang et al. (2013) examine the relationship between harmonic dissonance and roughness, while Harrison et al. (2018) integrate roughness, harmonicity, and familiarity. Hutchinson and Knopoff (1978) provide quantitative measures for acoustic dissonance in dyads and chords, focusing on beating frequency components, where close frequency components interfere with each other. The stimuli classified as consonants and dissonants were on the higher spectrum of the harmonicity and roughness scales, respectively.

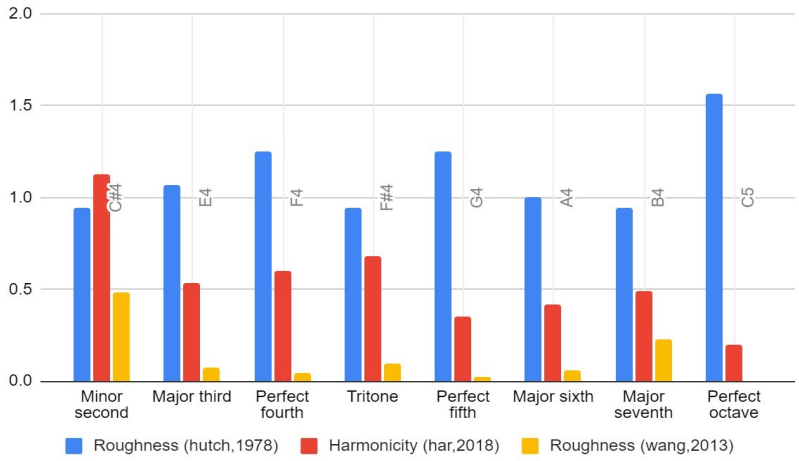

Figure 1: Mathematical Modeling of Dyad musical intervals. Frequency 1 was C4, and Frequency 2 varied from C#4 (minor second) to C5 (Perfect octave) on the musical scale and is indicated on the graph.

The pleasantness of stimuli was rated by participants on a seven-point Likert scale ranging from +3 to -3. For the neural block, the EEG data was recorded using a 64-channel scalp EEG with a sampling rate of 1000 Hz.

Results

Consonant stimuli were generally rated as more pleasant than dissonant stimuli, though not necessarily categorically distinct i.e., we also observed a preference for mild dissonance.

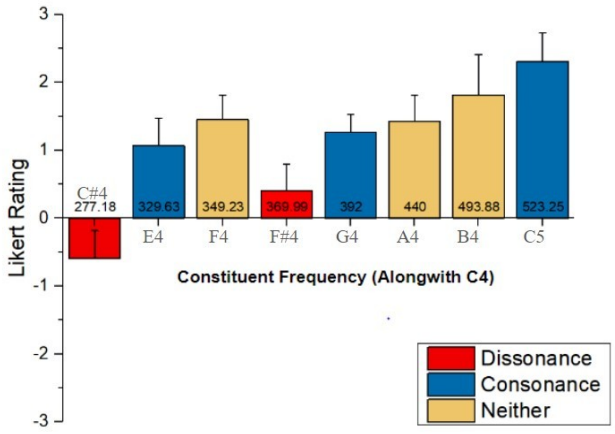

Figure 2: Behavioral results for dyad stimuli. Frequency 1 was C4, and the other constituent frequency is indicated on the graph.

For the neural responses, the average power spectral density (PSD) across participants was plotted for each stimulus to verify the peaks of constituent frequencies.

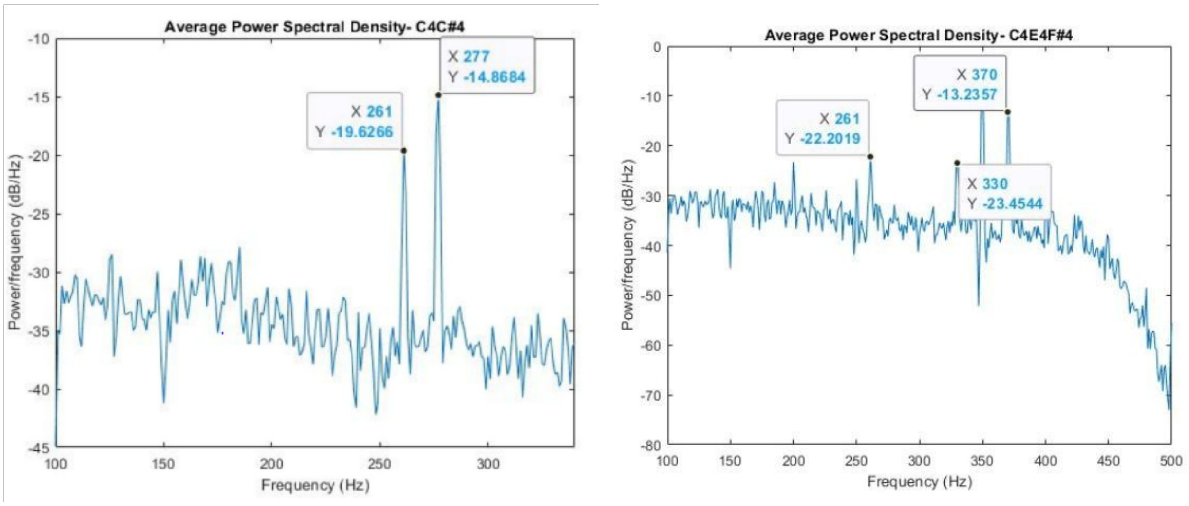

Figure 3: EEG power spectral density for dyad (left) and triad (right) stimuli.

FFRs for dyads show peaks at the constituent frequencies along the diagonal in Table 1, reflecting the synchronization of EEG activity to the stimuli. A direct comparison of the PSDs for dyads and triads (Figure 4) showed that dyads, with their simpler harmonic structure, produced more significant neural responses at their constituent frequencies. Triads, while eliciting peaks at their unique frequencies, showed reduced neural activation overall compared to dyads.

Table 1. Power Spectral densities of EEG responses to dyads at constituent frequencies.

	C4	C#4	E4	F#4	G4	A4
C4C#4	-31.15	-27.13	-35.25	-35.17	-34.32	-36.89
C4E4	-30.03	-34.22	-26.70	-35.09	-35.66	-39.98
C4F#4	-28.14	-33.28	-34.54	-29.70	-35.49	-40.35
C4G4	-32.71	-33.45	-34.17	-35.22	-31.07	-34.59
C4A4	-29.61	-32.90	-33.79	-37.20	-33.47	-33.38

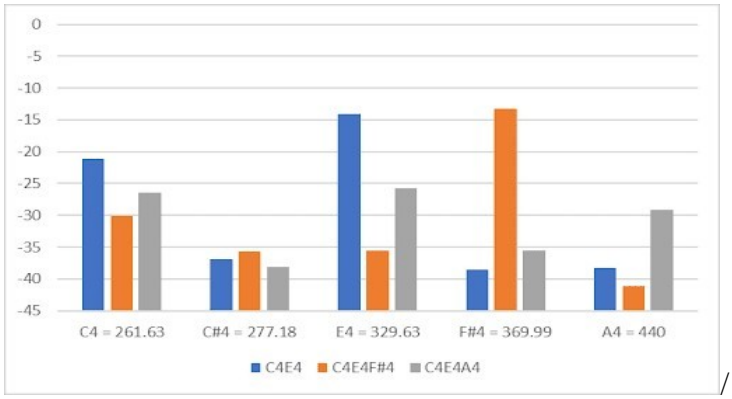

Figure 4: Comparison of dyad and triad power. C4E4 is a dyad stimulus, whereas C4E4F#4 and C4E4A4 are triads. Their activity is plotted at the respective constituent frequencies: C4, C#4, E4, F#4, and A4. C4 and E4 are frequencies common in both dyads and triads

Discussion

The study established the neural entrainment to dyads and triads with peak power spectral densities observed at frequencies corresponding to the musical stimuli's components. While we observed a behavioral difference in pleasantness ratings between the consonant and the dissonant stimuli, the FFR reflected no distinction between these stimuli. The preference for mild dissonance is in line with previous findings of Lahdelma et al (2016). In music theory, dyads are not considered chords in the traditional sense. Previous research on Consonants and dissonants by Bidelman and Krishnan (2009) had only looked at dyad stimuli. A dyad consists of only two notes played together, such as a major third (C and E) or a perfect fifth (C and G). While dyads create harmony, they don't qualify as chords because chords typically require at least three notes to establish a harmonic structure. We observed that the triads had overall reduced spectral power compared to the dyad stimuli. It might be that the FFR exhibits greater sensitivity to simpler harmonic structures, reflecting an inverse relationship between harmonic complexity and neural activation.

Session 5

Emotions and Driving: Effect of Emotions on Speed During Sudden Pedestrian Crossing Event

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Introduction

Driving is a complex visuomotor task that involves precise hand-eye coordination, fine motor skills, and spatial awareness. It requires extensive practice to achieve proficiency. However with enough experience, often the task becomes automatic, enabling the drivers to perform it with minimal conscious effort. Despite automaticity, driving remains a closed-loop skill that requires continuous monitoring and real-time adjustments based on feedback from the environment (Anderson et al., 2019). This continuous process of error correction and information processing is crucial for maintaining safe and effective driving performance.

In the same vein, the Task Capability Interface Model (Fuller, 2000, 2005) found that although with practice, driving becomes somewhat automatic, it can never achieve full automation. The model also highlights how drivers gauge safety margins by comparing the demands put forth by the driving task and their capabilities. These capabilities are shaped by the drivers' training, experience and physical, cognitive and affective factors. When capability exceeds demand, the driving task appears easy, when capability equals demand, the task is difficult and when demand exceeds capability, the driver may lose control of the vehicle. This self-assessment of abilities affects the perceived risk, which in turn affects the target risk impacting drivers' decision-making and responses.

Another important factor that influences decision-making (Mohanty & Suar, 2014), act as a distraction (Chan & Singhal, 2013), and impairs driving performance (Sullman & Dorn, 2019) is the drivers' emotional state. Emotions which are often overlooked in driving safety research, can be defined as complex states involving thoughts, feelings, actions, and physiological responses (Jeon et al., 2014). Negative emotions can significantly impact driving performance, resulting in poor vehicle control, increased speeds, and slower braking responses (Chan & Singhal, 2015; Kadoya et al., 2021). Additionally, negative emotions impair decision-making and increase the likelihood of taking risks (Hu et al., 2013; Yu et al., 2022), while those with higher emotional intelligence typically make safer choices on the road (Ahmed et al., 2022).

Emotions can vary widely, and effectively managing them is essential for safe driving.

Research Gap and Motivation

After an extensive literature review, it was found that there have been studies on anger and aggression of drivers but the effect of less aroused emotional states like pleasant and unpleasant emotional states on driving are still largely unexplored. This study aims to establish the effect of emotions, broadly classified as pleasant, neutral and unpleasant on the speed and braking behaviour of drivers. The study hypothesizes that (i) There will be a statistically significant difference in speed when drivers are in different emotional states. (ii) Drivers will speed up in an unpleasant emotional state compared to a pleasant emotional state.

Methods

Research gaps were identified after an extensive literature review and hypotheses were formulated. The International Affective Picture System (IAPS) (Branco et al., 2023; Lohani et al., 2013), which is widely used for emotion induction (Lang et. al., 2008), was used in the current study to induce pleasant, neutral and unpleasant emotional states. The IAPS images were categorized based on valence (positive or negative) and arousal (intensity of emotion). A set of 30 pleasant, neutral or unpleasant images was shown, where each image was presented for a span of 6 seconds with a gap of 2 seconds in between for emotion induction. Then the participants were instructed to drive a 10.8 km stretch on a fixed-based driving simulator where they had to navigate challenging situations like sudden pedestrian crossing. The process was randomised for all three emotional states. 95 drivers participated in this study out of which

13.6% experienced simulator sickness and had to quit. Among the remaining 82 participants, 88% were males and 23% were professional drivers.

Results

To explore the relationship between emotions and driving behaviour, linear mixed-effects modelling was used. To begin with, a baseline model was developed, incorporating random effects from participants. Factors such as emotion, age, experience, frequency, and gender were then individually added to this model to create different models. Using the forward method, variables were sequentially included based on their statistical significance to assess the additive effects, followed by examining interaction effects. To identify the best-fitting model, Akaike Information Criterion (AIC) was used.

Based on the above-mentioned process it was deduced that the Emotions, Gender and Driving Experience of the participant best explain the variation in speed during a sudden pedestrian crossing event.

The model formulation used in the analysis is as follows:

Average Speed ~ Emotions + Gender + Experience + (1 | Participant.Index)

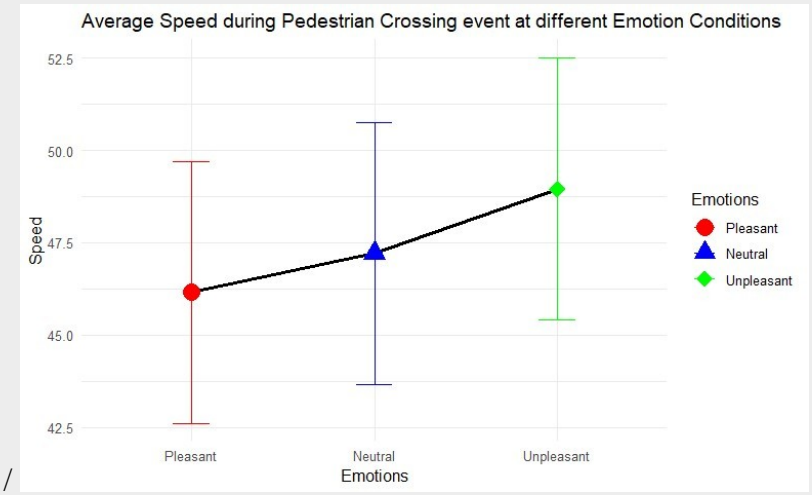
Fixed effects:

	Estimate	**Std. Error**	**df**	**P value**
Intercept:	55.91	1.34	111.15	0.000 ***
Neutral	1.06	0.96	160.00	0.272
Unpleasant	2.80	0.96	160.00	0.004 **
Gender (Female)	-11.4886	3.05	78.00	0.000 ***
Experience (Professional)	-8.03	2.37	78.00	0.001 **

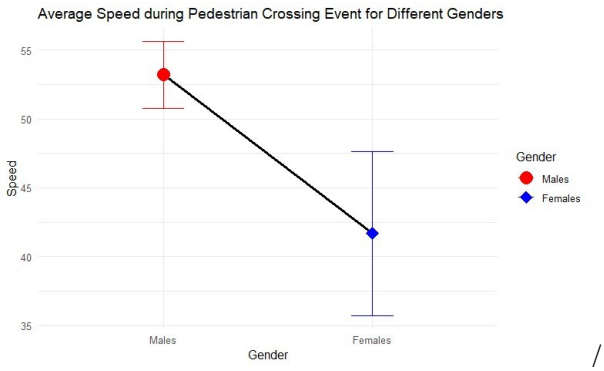
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1'' 1

Table 1: Fixed Effects of Emotions, Gender and Experience on Speed

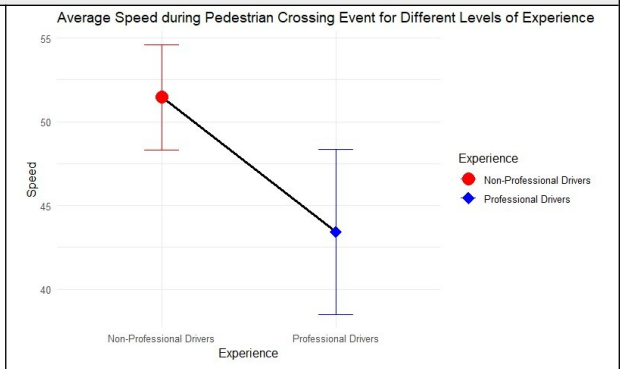
Table 1 depicts the fixed effects of emotions, gender and experience on speed. From the model, it can be inferred that when the drivers were male, non-professional and in a pleasant emotional state, the average speed was 55.91kmph. However, in the unpleasant emotional state, there was a statistically significant increase in the average speed by 2.80kmph though there was no statistically significant speed variation in the neutral state (Graph 1). It can also be observed that females (Graph 2) and professional drivers (Graph 3) significantly reduce their speed during a sudden pedestrian crossing event as compared to males and non-professional drivers.



Graph 1: Average Speed during Pedestrian Crossing Event at Different Emotion Conditions



Graph 2: Average Speed During Pedestrian Crossing Event for Different Genders



Graph 3: Average Speed During Pedestrian Crossing Event for Different Levels of Experience

Discussion

The findings indicate that the average speed was significantly higher when the driver was in an unpleasant state of emotion compared to a pleasant emotional state. Unpleasant emotions increase physiological arousal, impulsivity, and impatience (Mesken et al., 2007). The heightened arousal and impulsivity modify their perceived risk and thus affect decision

which in turn lead to higher speeds. This suggests that managing unpleasant emotions is critical for maintaining safe driving practices, as changes in perceived risk can significantly increase speed compromising road safety.

The average speed of male drivers was significantly higher than that of female drivers, which can be attributed to greater risk-taking and thrill-seeking behaviours among males, often linked to societal norms and biological factors (Rhodes & Pivik, 2011). Regarding driving experience, it was found that professional drivers drove slower than non-professional drivers. This difference may be attributed to a reduced inclination towards thrill-seeking among professional drivers, and possibly less exposure to screens and video games, which can promote higher speed tendencies, influencing driving behaviour.

Exploring User Engagement on Dating Apps: An Eye-Tracking Study

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CHRIST University

Introduction

This study explores the distribution of attention between images and textual elements in Bumble dating profiles, a context where such research has been limited. The study uses eye-tracking technology to analyse and compare user gaze metrics for patterns for profile pictures versus the accompanying text and its association with user response (swipe). Specifically, the study examines whether participants exhibit a significantly longer fixation duration on textual elements or pictures belonging to each profile. Understanding the balance of image and text is crucial for designing intuitive interfaces that enhance user experience and satisfaction. Although prior studies have shown that profile pictures often capture initial attention (Ehlers et al., 2024), the interaction between visual cues and text in shaping user perceptions remains underexplored. Research by Broeren (2020) and Pronk et al. (2021) underscores text simplicity's importance for attractiveness and pupil dilation in partner acceptance. Zhao et al. (2016) also highlight how visual attention can improve user experience on digital platforms. Culture influences eye gaze, and hence, focusing on Bumble, this research seeks to understand how attention is balanced between visual and textual elements and if this replicates findings from Western samples. The findings of this study are also aimed at improving user interface design in online dating platforms.

Methodology

This study currently has twenty female participants, and data collection is ongoing using convenience sampling. Participants are between 18 and 25 years old, identified as females, currently single or in a dating phase, looking for a heterosexual date, and spoke English. The exclusion criteria for the study were people currently in a relationship. The participants were invited to the Neuro-Cognition laboratory at Christ University, Bangalore, to take part in an experiment designed on Eyelink 100 plus (SR Research). After providing informed consent and undergoing an eye dominance test, they were comfortably seated, and the eye-tracking equipment was calibrated and validated. The experiment presented the participants with 20 male Bumble dating profiles, for which explicit consent had been obtained from the profile owners. The profiles were displayed on a monitor, and participants were asked to simulate the Bumble swiping action using keyboard keys—right arrow for "like" and left arrow for "dislike"—based on their impression of each profile.

The experiment consisted of 20 trials: 10 featured profiles with text and photos, while the remaining 10 featured profiles with pictures and minimal text. The primary measures of interest included the first fixation location (identifying whether participants initially focused on text or the profile picture), fixation duration on text, fixation duration on pictures, and changes in pupil size, which served as indicators of cognitive and emotional engagement. The experiment was designed using Experiment Builder, and participants' responses were recorded anonymously to ensure confidentiality.

Results

The analysis of profile visibility revealed variability, with some profiles achieving the highest face visibility score (8 points), while others scored as low as 1. Most profiles scored around 7, indicating good but inconsistent visibility, which could impact visual attention in the eye-tracking study.

Text content ratings also showed variation. The highest-scoring profile (5 points) had extensive text across sections like "My Bio" and additional text segments (T1, T2, T3), likely attracting more attention. Other profiles scored 2 points, while some had minimal text (1–2 points). Moderate profiles, scoring between 3–4 points, indicated less detailed content. This variation is expected to influence fixation and dwell times, with more detailed profiles holding attention longer.

Independent sample t-tests showed significant differences in fixation durations between Group 0 (left swipe) and Group 1 (right swipe). For text, the t-value was -2.49 ($p = .015$), and for pictures, -3.45 ($p = .001$), suggesting that visual attention influences swiping decisions.

Correlation analysis between first fixation duration and dwell time showed no significant relationship ($r = 0.02$, $p = 0.267$), indicating that first fixation duration does not predict overall dwell time in this study.

Discussion

This study highlights the critical role of visual elements, particularly profile pictures and textual elements, in driving user engagement on Bumble dating profiles. Interestingly, the correlational analysis revealed that the time an individual spends on a profile that is textual or visual content is not connected to the initial time an individual spends on a profile. This finding suggests that other factors, such as individual visual processing preferences or the inherent appeal of the images, might play a more substantial role in guiding user attention.

The study's findings are limited by the small sample size and variability in profile quality, which may affect the generalizability of the results. To improve the robustness of future research, a larger, more diverse sample should be used, and the stimuli should be standardized to ensure consistency. Additionally, exploring other factors, such as user personality traits or previous experience with dating apps, could provide further insights into designing profiles that better capture and maintain user attention.

Biopsychosocial Factors Affecting Illusion of Transparency

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Introduction

The illusion of transparency is a cognitive bias where individuals overestimate how apparent their internal states, such as emotions or thoughts, are to others. This review aims to systematically examine the biological, psychological, and social factors influencing this phenomenon, providing a comprehensive understanding and identifying areas for future research.

Methods

Search Strategy: Comprehensive searches were conducted in PsycINFO, PubMed, and Google Scholar using keywords such as "illusion of transparency," "cognitive bias," and "selfperception."
Selection Criteria: Peer-reviewed articles focusing on empirical studies related to the biological, psychological, and social aspects of the illusion of transparency were included.
Data Extraction and Analysis: Relevant data from selected studies were analysed for quality and relevance, with findings synthesized to identify key trends and research gaps.

Results

Biological Factors

The illusion of transparency manifests more strongly in children and adolescents than in adults, with younger individuals notably overestimating the detectability of their internal states, such as personal preferences or deception (Mandelbaum, 2014). Adolescent egocentrism further intensifies this bias, suggesting that interventions are needed to bolster self-confidence and communication skills in this age group (Rai et al., 2016).

Gender differences also play a role, with research showing that females are particularly susceptible to the illusion of transparency, especially in emotional contexts like disgust.

Females tend to struggle more with concealing their emotions and overestimate their visibility (Holder & Hawkins, 2007). Additionally, females are more likely to perceive their nervousness as more apparent than it actually is (Rai et al., 2016). These findings underscore the need for gender-sensitive strategies to effectively address the illusion of transparency.

Psychological Factors

The illusion of transparency significantly influences how individuals perceive the visibility of their truthfulness or deceit. Both liars and those experiencing strong emotions, such as disgust, often overestimate how apparent their internal states are to others (Mandelbaum, 2014; Gilovich et al., 1998). This bias extends to innocent suspects during interrogations, who mistakenly believe that their honesty is more evident than it truly is (Strömwall, Hartwig, & Granhag, 2006; Hartwig, Granhag, & Strömwall, 2007). In memory-based contexts, this overestimation persists, with individuals inaccurately judging others' ability to detect their truthfulness or deceit (Rai, Mitchell, & Faelling, 2012).

In the context of speech anxiety, individuals frequently overestimate how visible their nervousness is to the audience, leading to heightened anxiety and poorer performance. However, awareness of the illusion of transparency has been shown to improve performance and reduce anxiety (Savitsky & Gilovich, 2003). This is further supported by research indicating that understanding the illusion can mitigate anxiety and enhance speech quality

(Gloth, 2011; MacInnis, Mackinnon, & MacIntyre, 2010). Additionally, practice patterns are crucial in managing public speaking anxiety, as they directly influence fluency (Goberman, Hughes, & Haydock, 2011).

The anchoring and adjustment effect also plays a significant role in the illusion of transparency. Individuals often overestimate others' ability to discern their internal states due to this cognitive bias (Jinsheng, 2011). This effect is exacerbated by the tendency of people to rely too heavily on their own experiences when predicting others' perceptions, leading to a skewed estimate of transparency (Gilovich et al., 1998).

A key element in the illusion of transparency is self-awareness, as individuals with higher levels of self-awareness are more likely to overestimate how much others can perceive their internal states (Vorauer & Ross, 1999). This tendency is especially pronounced in younger people, where increased self-consciousness amplifies the bias (Mandelbaum, 2014). Additionally, individuals with low self-monitoring skills are more prone to this illusion compared to those who are better at regulating their behavior, highlighting the role of self-monitoring in managing this cognitive bias (Jin-Sheng & Li-Zhu, 2009).

Social Factors

Social and Interpersonal Factors: The illusion of transparency is influenced by various social and interpersonal contexts. Marinetti & Parkinson (2009) investigated the effects of social context and relationship closeness on this bias, finding that while interaction context (e.g., interacting with friends versus strangers) affects perceptions of facial behavior, the closeness of the relationship does not consistently impact the illusion. Parkinson (2008) further examined how different interpersonal contexts, such as face-to-face and remote interactions, influence emotional expression and perception, contributing to the illusion of transparency. Marinetti, Moore, Lucas, & Parkinson (2011) expanded on this by exploring how ongoing social interactions shape emotional responses, thereby affecting the illusion of transparency.

Social anxiety is closely linked to the illusion of transparency, with cognitive vulnerabilities like fear of negative evaluation interacting with social and temporal factors to predict social anxiety and performance deficits (Haikal & Hong, 2010). The illusion of transparency was found to be more pronounced in low social-evaluative conditions than the spotlight effect (Brown & Stopa, 2007). Moreover, understanding the illusion of transparency has been shown to improve speech quality and reduce social anxiety (Gloth, 2011).

In negotiations, less powerful negotiators are more likely to perceive their internal states as transparent compared to more powerful negotiators (Garcia, 2002). Similarly, research by Van, Gilovich, & Medvec (2003) demonstrated that negotiators often overestimate how much their concealed preferences are discerned by their counterparts, leading to potential negative impacts on negotiation outcomes and communication accuracy.

The illusion of transparency also spans various interpersonal interactions, including bystander apathy, criminal trials, and close relationships. Yuanjie (2010) provided a comprehensive review of theoretical interpretations of this bias, such as anchoring and adjustment effects, selfawareness, and naïve realism, offering a broad understanding of the illusion across different domains.

In performance appraisal settings, the illusion of transparency plays a significant role. Schaerer et al. (2018) found that managers often overestimate how accurately employees perceive their feedback, particularly in negative evaluations. This transparency illusion was influenced by managers' insufficient motivation to be accurate, highlighting the need for interventions to address this issue.

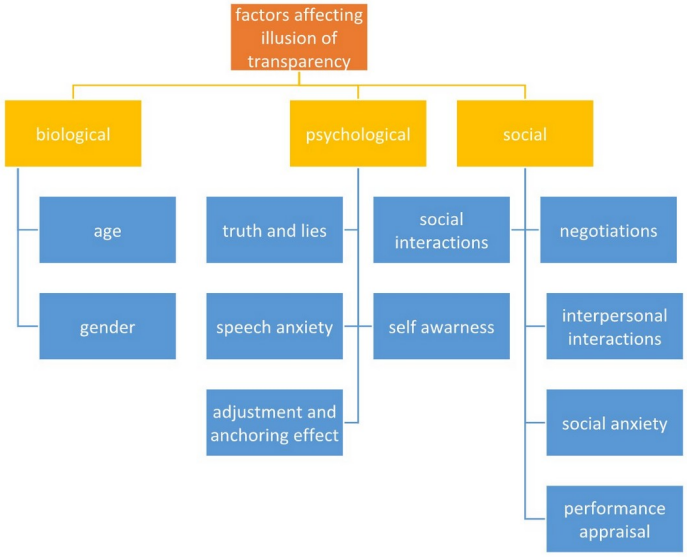

Figure1: Factors affecting illusion of transparency

Gaps in the Literature

While significant research has focused on developmental and gender differences in the illusion of transparency, there is a lack of studies on cultural factors and individual differences such as personality traits. Future research should explore these areas to provide a more comprehensive understanding of the bias.

Discussion

This review synthesizes findings on the factors influencing the illusion of transparency, categorized into biological, psychological, and social domains. The key factors identified include age, gender, speech anxiety, truth and lies, self-awareness, adjustment and anchoring effects, social anxiety, interpersonal interactions, social interactions, negotiations, and performance appraisal.

Despite the extensive research conducted over the past 20 years, there remains a limited amount of literature on the illusion of transparency. Future studies should focus on demographic factors such as ethnicity, culture, and race, and explore strategies to reduce the impact of the illusion. Identifying effective interventions can enhance communication skills, negotiation abilities, and lie detection. Further research is essential to advance our understanding and practical application of this cognitive bias.

Practical Implications and Interventions

Awareness and Self-Distancing Techniques: Increasing awareness of the illusion of transparency can help individuals manage self-perceptions and reduce anxiety. Techniques such as self-distancing and seeking feedback can mitigate the bias.

- Debiasing Strategies: Employing debiasing techniques, such as improving perspective-taking and creating optimal conditions for rational thinking, can further reduce the impact of the illusion of transparency.

This review highlights the need for continued exploration and development of strategies to address the illusion of transparency, with implications for various domains including communication, negotiation, and performance evaluation.

Task Irrelevant Self-relevant Primes Engage Attention

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Introduction

Though Self has been posited to be the fundamental unit of analysis for psychological science (James,1980), the current best attempts at defining it is as a sui generis multifaceted entity that does not submit to clear and precise descriptions (Klein, 2012). The philosophical discourse on self seems to converge on the assumption that self is the pinnacle of all functions that provide a unique and unified sense of existence through time and space (Northoff, 2016). Extending this notion to neuroscience and psychology, initial research conceptualized the self as a higher-order cognitive function, most possibly the highest function of the brain, with metarepresentation and a specific higher-order network or regions (Churchland, 2002). However, the later developments suggested that self or rather the association with self seems to be modulating even lower-order functions such as perception, emotion, reward, and action. It is now being argued that self could be the most fundamental function of the brain, underlying all other cognitive processes (Northoff, 2016).

Though studies have consistently shown response facilitation- in terms of faster responses, enhanced accuracy and decreased sensitivity- to targets when they are associated with one's own self than when associated with a stranger, there is lack of clarity on whether the Self is the sole driver of this "self-prioritization". Though a few studies do attempt to address this lack of clarity on the equivalence of pre-existing and novel self-associations, they have either drawn their inferences by comparing the magnitudes of the self-biases from two different experiments, each employing either pre-existing or novel self-associations (Scheller& Sui, 2022) or have failed in eliciting any response facilitations to novel self-associations as compared to stranger associations (Orellana-Corrales et al., 2020).

The present study directly compares the attentional biases enjoyed by pre-existing and newly associated self-related information using a cueing task, by controlling for the possible factors that could have acted as barriers in the formation of the novel self and stranger associations (e.g. Orellana-Corrales et al., 2020).

Method

Twenty-five students from IIT Roorkee (M= 25.5, SD=1.32; 9 females, 16 males) with normal or corrected-to-normal vision, participated in the experiment. Before the participants came to the lab, an object belonging to them (e.g. their watch) was collected by the experimenter and photographed in a controlled environment (henceforth referred to as the Actual Self), such that it matched in both higher-order and lower-order features of the images of the same class of objects in a previously stored database.

The experiment started with a Training phase where the participants were first exposed to two images from the same object class as the previously collected object from them(here, images of two watches, from the created database) and trained to associate them with self (henceforth referred to as the Acquired Self) and stranger as indicated by the randomly assigned labels alongside the images. These associations were reinforced using an associative-learning paradigm adapted from Sui et al. (2012) for 240 trials (120 per association).

The Training phase was followed by the experimental session, where participants were required to respond to the orientation of a horizontal or vertical line by making appropriate keypress, as fast and as accurately as possible. The target was primed by an uninformative spatial cue (validity-50%) that could either be the image relevant to the Actual Self, Acquired Self, or Stranger (180 trials divided into 60 trials per label).

Results and Discussion

A 3 (Association: Actual Self, Acquired Self, Stranger) x 2 (Validity: Valid, Invalid) repeated measures ANOVA on RT showed a significant main effect of Validity [$F(1,24)=12.84$, $p=.001$, $\eta p2=.34$), with no other significant main or interaction effects (Fig. 1).

Acquired Self (62 ms), while no significant effect obtained for the Stranger condition (34 ms). The results show that despite the cue being uninformative, a cueing benefit is observed for selfrelated information alone, indicating that self-related stimuli can capture attention even when they are not task-relevant or uninformative. This attentional bias is enjoyed equally by both pre-existing and novel self-associations, providing strong support to the notion that sheer association to Self is what drives Self-prioritization.

Though Sui et al. (2012) developed the Perceptual Matching Paradigm to counter the familiarity confounds associated with Self-related stimuli, it is still not clear whether an acquired self-relevance is comparable with a pre-existing self-association. The equivalence of both kinds of Self-associations in eliciting an attentional bias, as in the present study, not only suggests that Self is the sole driver of the observed prioritizations of Self-referent information but also implies the idea of a core Self-representation that is activated by anything self-associated. However, further studies need to be done to see if this equivalence is present only in the attentional stage or if self-association is prioritized similarly across all cognitive domains, regardless of the nature (familiarity) of the association.

The impact of mental fatigue on the working memory capacity and executive functions of young adults

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People who work for long hours in corporations, or students who have a lot of academic pressure experience cognitive load due to which their working memory capacity as well as their executive functions such as decision-making, problem solving etc., decreases with time. There is a paucity of studies reporting the correlation of fatigue with the cognitive functions in young adults in the Indian context and hence it was the need of the hour to conduct such a study.

The basic idea behind this research emerged from the concept that Baddeley suggested about working memory (WM), which model emphasises the role of central executive resources in strategic processing of information held in temporary stores. Working memory, a subset of executive function, temporarily holds and manipulates information. Cognitive load, the mental effort required for a task, impacts working memory as excessive load can overwhelm it. Executive function regulates cognitive processes. Therefore, an intricate relationship exists: cognitive load affects working memory, and both contribute to the functioning of executive processes in managing tasks and decision-making.
In adults, there is a significant relationship between cognitive fatigue, working memory load, and executive functioning. In this study, I am trying to investigate the impact of cognitive load on working memory capacity and executive function in young adults who have working hours of 8 or more per day. This study used cognitive function tasks such as Stroop task, n-back tasks along with questionnaires which included Kuppuswamy Scale (assessing Socioeconomic status), Perceived Stress Scale (PSS-10), Visual analogue to evaluate fatigue severity (VAS-F) for assessing subjective fatigue and Mental Fatigue Scale (MFS) for assessing objective fatigue.

The results of the cognitive function tasks performed show that whenever there is a task with a low load, the differences in RTs (Reaction times) and accuracies between the groups (low and high fatigue groups) are similar but if we increase the load and the duration along with the difficulty of the tasks, we notice a significant difference in the RT (Reaction time) of 2-back task, this happened because by the time participants performed the 2-back task, they (high fatigue population) were already exhausted from doing the previous tasks and hence we see a difference in RT but not in accuracy. On reviewing the results, it was concluded that “Eustress” arises in these situations and hence, such results are seen.

Studies like these help us in developing personalised cognitive training programs for every age group and occupation. Additionally, these programs can pave the way for tailored therapeutic regimes for people with specific neurodegenerative disorders or attention-related challenges and can also be helpful in designing brain-training games for children as well as young adults.

Keywords: Executive functions, Working memory, Inhibitory control, Mental fatigue, Perceived stress

The Effect of an Episodic Future Thinking Strategy on The Prospective Memory of People with PCOS

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Introduction

Future-oriented cognitions have piqued the researchers' interests in the past few years. Prospective memory (PM) is one such form of future-oriented cognition that refers to the ability to carry out a planned action (Terrett et al., 2015). Based on the retrieval cue, PM is further classified into event-based and time-based prospective memory. PM is implicated in the daily functioning of individuals in the form of remembering to join a meeting at a certain time, taking medication after meals, etc.

Episodic future thinking (EFT) is another form prospection, involving the ability to "imagine or simulate events that might occur in one's personal future" (Schacter et al., 2017).

Recent research has uncovered a positive connection between EFT and PM. Studies reveal that EFT is a significant predictor of PM since the age of four (Nigro et al., 2014; Terret et al., 2015). Previous literature states that EFT reduces mind-wandering during tasks and processing costs during retrieval of PM tasks (Gollwitzer, 2014). Additionally, EFT allows individuals to pre-experience the retrieval cues, which are then detected more effectively later (Terrett et al., 2015). Therefore, EFT can be used for people with conditions that implicate the PM.

One such condition implicating PM may be Polycystic Ovary Syndrome (PCOS). With its prevalence in India ranging from 4 to 22% (Ganie et al., 2019), PCOS is characterised by hyperandrogenism and insulin resistance, both of which influence brain functioning (Rees et al., 2016). However, there is a gap in research regarding PM performance in people with PCOS.

Given the importance of PM in everyday life, especially to those with conditions requiring routine medications and lifestyle changes such as PCOS, it is imperative to study the extent of the deficits and easy-to-use techniques such as EFT to overcome them. Therefore, the present study jointly aims to investigate the PM performance of people with PCOS and the effects of an EFT strategy on the time-based and event-based PM performance of individuals with PCOS.

Method

The study adopts a quasi-experimental research design wherein the participants, aged 18 to 27, form three groups: the healthy controls (HC, n=9) , the PCOS group engaging in the EFT protocol (EG, n=6), and the PCOS group not engaging in the EFT protocol (DEG, n=5). Kindly note that the study is still undergoing data collection which will terminate when each group has 15 participants. The PM tasks administered and scored according to the Royal Prince Alfred Prospective Memory Test (Radford et al., 2011). The ongoing tasks included the Flanker Task and PEBL Continuous Performance Test (PCPT) administered using the PEBL 2.1 software. Moreover, the cognitive functioning and severity of depressive and anxious symptomatology was recorded within an intake form using the Montreal Cognitive Assessment (MoCA), Beck's Depression Inventory (BDI II), and the Beck's Anxiety Inventory (BAI), respectively.

The EFT Protocol

The EFT strategy encompasses closing one's eyes to visualize their surroundings then verbally repeating a script read out by the examiner that includes when/then statements in relation to the PM tasks and their cues. In this sense, the EFT protocol adopted here employs the elements of imagery (Neroni et al., 2014) and implementation intention (Gollwitzer, 2014) used in previous to improve PM. This strategy was administered to the EG after PM task instructions were explained.

Results

So far, the results indicated that there were no significant differences between the DEG and HC on scores of any of the tools ($p>0.05$). Moreover, there were no significant differences between the DEG and EG on any scores ($p>0.05$)besides reaction time on PCPT ($p<0.05$). Conversely however, the average PCPT reaction time for the DEG group was significantly lower than that of the EG ($t=-2.34, p=0.022$).

Discussion

The results will be discussed once data collection has been completed as the findings may evolve as the sample size increases. This research contributes to the body of knowledge on a population that has so far been underrepresented in academic literature. The findings will not only strengthen our knowledge of the cognitive functioning in PCOS but potentially also help develop strategies to improve it.

Learned Helplessness suppresses Action Bias and not Pavlovian Bias

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Introduction

Depression affects more than 330 million people worldwide and is a significant cause of disability, devastating the lives of those affected and those around them[1]. Although great strides have been made in our understanding of the disorder as well as treatment avenues, knowledge about the underlying mechanisms of the disorder is still lacking, perhaps due to heterogeneity of the condition, lack of good translational and cross-species models. Inspired by RDoC, recent studies have shifted emphasis towards modeling specific depressive phenotypes and delineating the neural underpinnings thereof. Learned-Helplessness (LH) or despair-like behavior is one such phenotype that is less well understood. Even though there are some good animals models the construct validity of these is not well established. However, there are not many human studies and the neural correlates are not well understood [2]. LH is a condition that occurs when exposure to uncontrollable stress causes an expectation of helplessness in the future, leading to a lack of motivation to overcome challenges. Laboratory induction shows subjects (humans and animals) are more likely to give up, and also show additional cognitive deficits, similar to depression[2,3,4]. While traditional paradigms depend on problem-solving ability as a marker of LH, we have designed a new experiment which offers a more continuous estimate of LH. Using this assay we show that LH suppresses action bias, our tendency to act for rewards, and not Pavlovian bias.

Experiment

LH tasks have two major components: an induction task to induce LH, and a testing task to assess its effects. Both tasks had practice blocks. Our induction task is a modified Levine task[5], which has been used successfully before[6,7]. We use cards with 4 different structural properties - with two variations per property (Fig.1). For each problem, one particular variation of one particular property is the target, and the participant has to identify it, based on feedback as to whether the target was present or not in the chosen card in a trial. In the control (contingent) group, the feedback is veracious, while in the experimental (incontingent) group, the response is predetermined to be 50% positive. Similarly, the computer's response may be veracious, or 'wrong' for the participant's choice of target, depending on the group. In total, there are 3 problems of 10 trials each, with no in-game rewards other than the feedback.

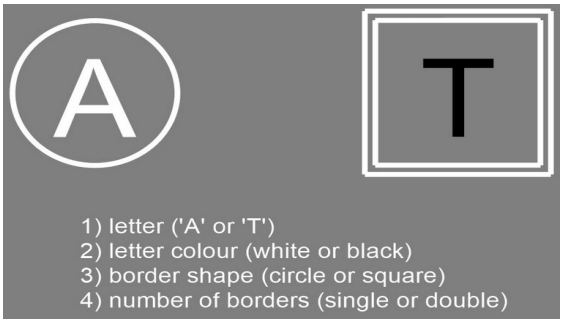

Figure 1. Levine task card examples, and properties and variations

For the testing task, we used a modified version of the orthogonalized go/no-go (GNG) task[8], with an explicit aim to maximize score (Fig.2). In each trial, the participant has to determine whether to respond (key-press) or not, depending on their interpretation of the properties of the card shown. There are 20 trials per card in each block. Administration of the task was the same for all groups – 70% of the outcomes were veracious, with 30% being the opposite outcome. Rewards were 10 (reward card), neutral was 0 (common), and punishments -10 (punishment card). There was also a go-cost of 1 point (-1 effectively) representing the cost of physical effort.

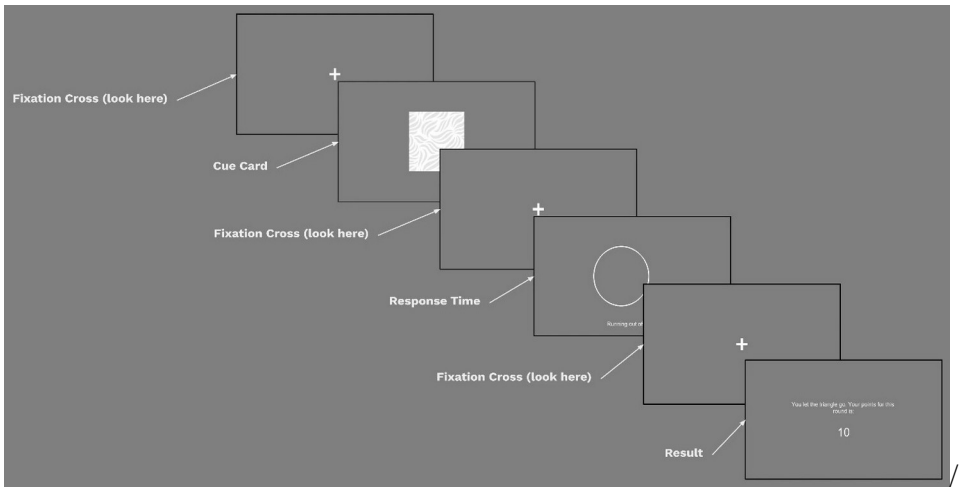

Figure 2. GNG task overview

Methods

Participants

N=55 participants were recruited double-blind, of which 50 were retained for analysis (control=22, experimental=28). Further collection aims to double this number (power analysis).

Analysis

Model free analysis used linear mixed models (LM)[9,10] whereas model based analysis included hierarchical reinforcement learning models with parameters included to estimate Pavlovian and action biases HBayesDM (HBDM)[11]. The effects tested for in the linear models were a combination of the Pavlovian performance biases (PPB), punishment-based suppression (PBS) and reward-based invigoration (RBI).

$$PBS = \frac{NG_l}{NG_T}$$
$$RBI = \frac{G_w}{G_T}$$
$$PPB_I = PBS - RBI$$
$$NG_l = no response in losing cards;\ NG_T = total no response\ in\ game;$$
$$Gw = responds in winning cards; GT = total responds in game$$

Note: PPBi represents some form of action bias, which actually makes sense considering the expansion of the formula.
/

$$\begin{aligned} PPB_I &= PBS - RBI \\ &= \frac{NG_l}{NG_t} - \frac{G_w}{G_T} \\ &= \frac{NG_l}{NG_T} - \frac{(1 - NG_w)}{G_T} \\ PPB_I &= \frac{NG_l}{NG_T} + \frac{NG_w}{G_T} - 1 \end{aligned}$$

For HBDM, models that included both biases were seen to have the best LOOIC values on average across dataset subgroups.

Results

Pavlovian bias (PB) is known to take precedence in GNG decision-making when control is attenuated [12] . Since LH results from loss of subjective control, we hypothesized that PB would increase with induction of LH. However, markers of PB – PBS, RBI – did not show significant differences when accounting for group (control vs experimental) and time (pre vs. post induction). However, the change in PPB_I post LH induction, which is a measure of action bias, showed significant decrease (Interaction effect of group and time: -0.7±0.3, t = 2.1, $p < 0.05$). While these results suggest that action bias decreases, to better capture the reduction in bias we used reinforcement learning (RL) models that explicitly model Pavlovian and action biases.

4 versions of RL models (simple RL, one with action bias, one with action and Pavlovian bias and one with both biases and differential learning based on positive and negative feedback) were implemented for all the combinations of group and time. The last model best captured the data with the lowest LOOIC scores. After parameter estimation, we observed that the changes in PB in the incontingent group (fig 5, left side, upper panel), contingent group (fig 5, left side, bottom panel) remain comparable between pre and post LH induction. However, action bias is significantly reduced post LH induction in the incontingent group (Fig.5, right-top panel), which is not the case in contingent pre and post (right-bottom panel).

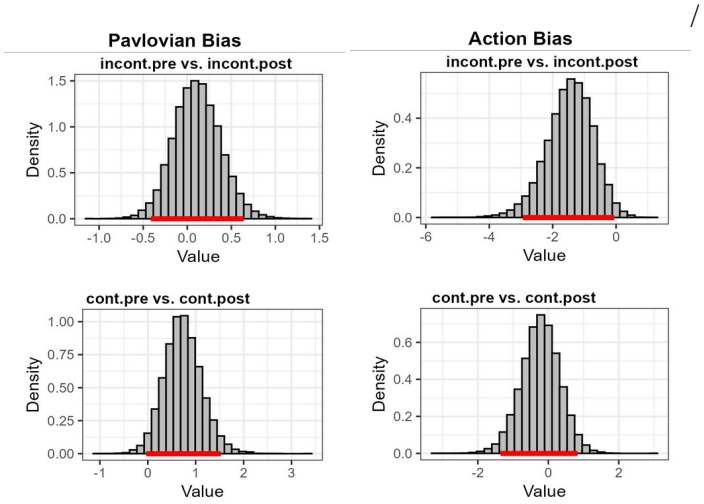

Figure 3. Group-wise differences in pavlovian bias (pi) and action bias (b) in HBDM gng.m4 model

Conclusion

In this study we show that the GNG paradigm can provide a readout of induced LH. However, induction of LH leads to reduction in action bias and not Pavlovian bias. These results suggest that LH induction affects the motivation to perform actions in the face of uncertainty which may happen through a circuit that is independent of the cognitive control circuit that regulates Pavlovian bias.

Models, Modalities, and Features: Classification of Affective Music Video Clips and Participants from Neural Signals

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Introduction

Electroencephalography (EEG) and Magnetoencephalography (MEG) are key neuroimaging modalities that capture real-time brain activity with excellent temporal resolution, while MEG has a relatively better spatial resolution (Cohen, 1972; Hämäläinen et al., 1993). These modalities effectively capture and examine neural responses to various stimuli, including audio-visual inputs (Hari & Salmelin, 2012). Shahin et al. (2007) found that sound spectrum complexity influences EEG responses. MEG research has shown that low-frequency neural phase modulation is needed for tracking dynamic multi-sensory information (Luo et al., 2010). EEG can also predict emotional responses to audio-visual stimuli, exhibiting its sensitivity to complex brain signals (Koelstra et al., 2012).

This study looks into neural activity by utilizing machine learning models for two multi-class classification tasks: predicting the specific music-video clip a participant is watching (clip prediction) and identifying the participant based on brain activity (participant prediction).

Our findings reveal task-specific performance differences between EEG and MEG modalities. Reichert et al. (2017) showed that MEG detected event-related fields (ERFs) better than EEG during a covert attention test, with the combination improving performance. Reichert et al. (2017) also found that EEG data performed better than MEG in cross-subject classification, exhibiting EEG's transfer learning abilities. These studies overlook the dynamic character of brain activity, which mainly focuses on task-based networks utilizing static or controlled stimuli. Our work bridges this research gap by examining neural reactions to dynamic, time-varying audio-visual stimuli such as music-videos. We accomplish categorization tasks based on neural signals and move forward with the approach by capturing the intricacy of the brain's response to more dynamic content.

Methods

This study employed two datasets collected under the same audio-visual stimuli but with different subjects and neuroimaging modalities. The preprocessed EEG data, obtained from the DEAP dataset (Koelstra et al., 2012), consists of recordings from 32 people subjected to 40 distinct one-minute music-video clips. The MEG time-frequency analysis (MEG TFA) data is acquired from the DECAF dataset (Abadi et al., 2015), which consists of 30 people exposed to the same 40 music video clips.

We utilized the 1D CNN architecture to identify clips and participants based on EEG data. This model was selected due to its ability to capture temporal dependencies in time-series data, essential for evaluating brain signals (Zhang et al., 2023; Song et al., 2021). The XGBoost classifier was chosen for MEG data as it can work well with high-dimensional data and effectively handle missing values (NaN) frequently present in the MEG TFA data (Suresh & Reddy, 2022).

Results

The 1D CNN model predicted audio clips using EEG data with **71.35%** accuracy, showing a strong ability to distinguish brain signals. However, the XGBoost classifier using MEG data only achieved **30.21%** accuracy for the same test.

The participant prediction test showed that the CNN model was **99.89%** accurate on EEG data, while the XGBoost classifier was **98.90%** accurate on MEG data.

Discussion

Performance differences between clip and participant predictions shows the importance of task-specific signal properties and model compatibility. The 1D CNN model's higher clip prediction ability on EEG data puts light on the relevance of temporal resolution in tasks that require detecting minute changes in how the brain processes auditory stimuli. EEG can capture quick, time-sensitive brain responses which makes it better to work with when identifying closely timed stimuli like music-video snippets. The MEG-based XGBoost classifier's lower performance in this task shows that clip prediction relies more on the brain's temporal dynamics than spatial resolution.

EEG's capacity to detect varied neural characteristics and capture tiny individual differences, while MEG's excellent spatial resolution may help discover distinct, location-specific brain activity patterns.

These findings complement prior research indicating EEG is more sensitive to auditory-evoked responses (Shahin et al., 2007) and that EEG and MEG effectively identify individuals (Siems et al., 2016). The results for participant prediction across modalities show that EEG and MEG may be chosen more by availability and cost than by superiority in identifying individuals. Our study shows proof that neuroimaging for machine learning must be task-specific. Plan for future work is to integrate cross-modal data, work on EEG and MEG extracted features, and further expand our scope for research by exploring more modalities.

The Dichotomy of Bias Behavior: Inhibition of Automaticity in Ingroup Bias for Deliberative Decisions

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Introduction

An essential aspect of human adaptation and survival throughout millions of years of evolution has been the capacity to inhabit large social groups (van Vugt & Kameda, 2012). Darwin (1871) emphasized that group living afforded individuals access to shared resources, such as food, water, and reproductive opportunities, while also providing protection against predators and rival groups. This phenomenon of communal living is deeply rooted in evolutionary theory, underscoring the necessity for individuals to categorize others as either members of their ingroup or as outgroup members to fully leverage the benefits of social cohesion (van Vugt & Kameda, 2012). Sumner (1906) introduced the term "ethnocentrism" to describe this innate tendency to organize social worlds into ingroups and outgroups, which subsequently informs behaviors towards others. The concept of ingroup bias, which refers to the differential cognitive processing of ingroup versus outgroup members, can manifest both explicitly and implicitly (Amodio & Mendoza, 2010). This cognitive framework is particularly relevant in the context of the modern information age, where the interplay between social identity, media consumption, and the evaluation of information shapes intergroup attitudes and behaviors. In the contemporary information age, characterized by a plethora of media outlets, research on intergroup dynamics has consistently highlighted the phenomenon of ingroup bias. This bias manifests as a tendency for individuals to favor members of their own group, demonstrating a greater inclination to trust positive information about the ingroup, particularly when such information originates from high-reliability sources (Hewstone et al., 2002; Mackie & Smith, 2015). Conversely, negative information regarding the ingroup, especially when sourced from low-reliability outlets, is often met with skepticism (Hornsey, 2008). In contrast, information pertaining to outgroups is typically subjected to more critical evaluation, particularly when derived from less credible sources (Clark et al., 2020). Furthermore, the current socio-cultural climate often compels individuals to adopt a "politically correct" demeanor to circumvent potential conflicts in social interactions. This social pressure may contribute to the discrepancy between implicit and explicit expressions of bias; while various methodologies, including the Implicit Association Test and priming studies, have consistently demonstrated the presence of implicit ingroup bias in cognitive tasks, overt displays of such biases are notably rare in experimental contexts. This suggests a complex interplay between societal expectations and the underlying cognitive processes that govern intergroup attitudes and behaviors.

Following the framework of minimal group paradigm, in this study, we explored participants ingroup favoring behavior for news information using a 2x2x2 factorial design. The independent variables were (i) news source reliability: (a) high reliability news source, (b) low reliability news source; (ii) valence of news headlines: (a) positive, (b) negative; and (iii) grouping condition: (a) minimal ingroup, (b) minimal outgroup. The dependent variable was participants' believability of the news headlines, marked by judging a piece of news information as True News. Two experiments were carried out with different sets of participants using the same design but limiting the reading and response time in the second experiment.

Methods

The experiment consisted of two phases. In the first phase, participants got familiarized with the two newspapers: ABC News and XYZ News. The underlying probability, not explicitly told to the participant, of the high reliable source giving correct information was set as 75%

and for the low reliable source was set to 25%. ABC News and XYZ News were

counterbalanced to be high and low reliable sources. A total of 96 newspaper headlines were presented to the participants to be judged as True News or False News, and they were asked to track the reliability of the two newspapers. Of the 96 news headlines, 64 news headlines served as learning block with feedback provided to the participant after each trial judgement. The other 32 news headlines served as the test block where participants judged the news as true or false without any feedback. After this, a screen was presented to the participants where they were asked which newspaper they felt was more reliable. This was asked as a 2AFC decision. Next, on the same screen, participant rated the reliability of the two newspapers in two different rating scales, one for ABC News and the other for XYZ News, with ratings going from 0% reliable to 100% reliable.

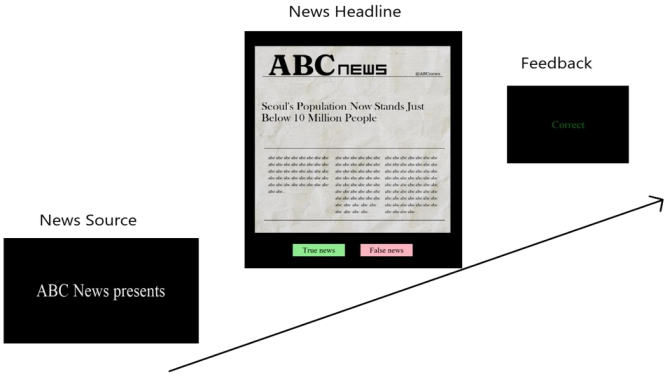


Figure 1**.** Example task in Phase 1. The trial started with an on-screen display of news source, followed by the news headline. Feedback was provided in learning block of phase 1, but not in testing block. Phase 2 had same task structure (without feedback).

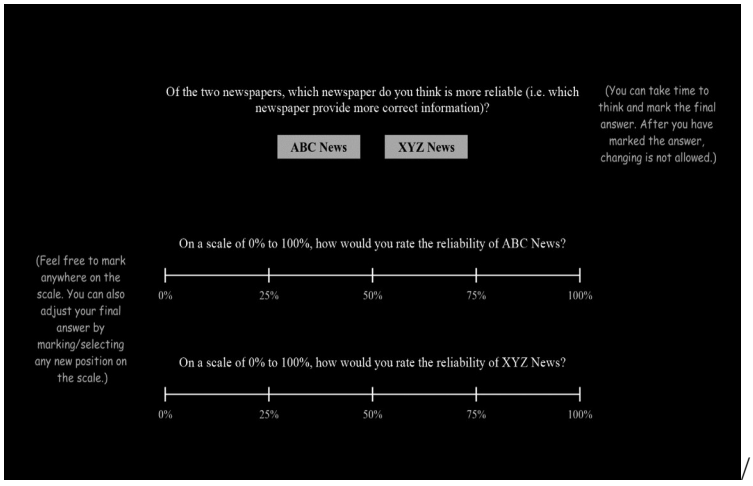


Figure 2. Obtaining perceived reliable news source and perceived news source reliability.

Phase 2 began with participant getting familiarized with two arbitrary groups in a society: JAWAAI and RUPRAA. These were Hindi non-words and thus novel to each participant. Following the minimal group framework, the participants were randomly categorized into either of the two minimal groups. After the minimal group categorization, participants were instructed of the upcoming task which was again to judge a news headline as True News or

False News. These news headlines came from the previously learned newspapers ABC News and XYZ News, and the content of the information in these news headlines were (i) Positive news about participant's ingroup, (ii) Positive news about participant's outgroup, (iii) Negative news about participant's ingroup, and (iv) Negative news about participant's outgroup.

Experiment 1 used a fully randomized presentation of 72 news headlines in three blocks, 24 news items per block. Like in phase 1, participants judged the news as true or false without any time bound. For experiment 2, we used a blocked design presentation of 64 news items in two blocks, with either all 32 ingroup news items presented first or outgroup news items presented first. The newspaper stayed on the screen for 6 seconds and then disappeared followed by the presentation of judgement choices. Participant had 2 seconds to respond whether the news item is true or false, failing which a prompt asked them to respond faster.

Prior to running the experiment, pilot study of phase 1 yielded that the participants were able to learn which newspaper was more reliable, approximating the underlying probability of each newspaper's truthfulness. The news headlines used in the second phase was selected from among 270 news headlines after valence rating was taken from 30 participants. The 36 most positive and 36 most negative rated news headlines was used in experiment 1, and a subset of it with 32 most positive and 32 most negative was used in experiment 2.

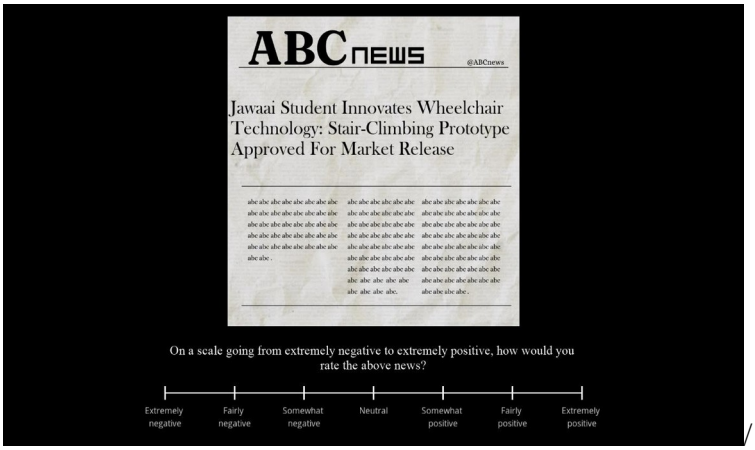


Figure 3. Example task in the stimulus pretest. Rating of 270 news headlines about Jawaai and Rupraa communities were taken. 7-point discrete scale was used, going from extremely negative to extremely positive.

Results

(The study is currently ongoing with 18 data in exp 1 and 12 data in exp 2. The results presented is from the same. We expect to complete the full data collection and analysis before the conference.)

For phase 1, participants were able to differentiate the reliability of the two news sources for both the experiments, with participants approximating 70.8% reliability for the high

reliable source and 47.6% reliability for the low reliable source in the experiment 1, and with 77.4% reliability for the high reliable source and 36% reliability for the low reliable source in the experiment 2.

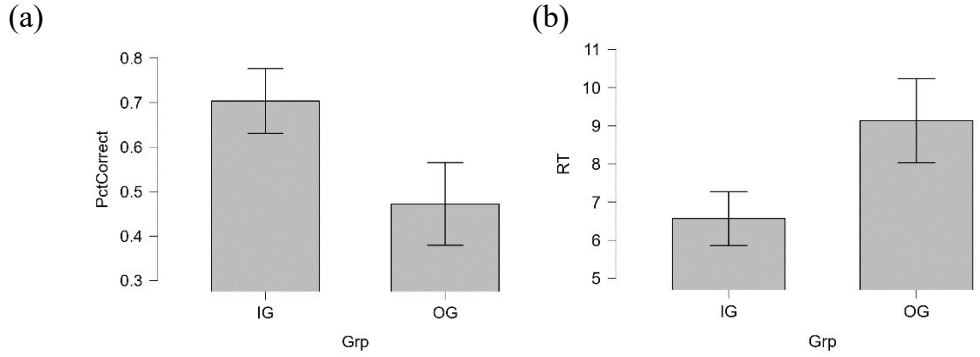
For phase 2, participants believability of the news sources was analysed for both the experiments. Specifically, we looked at four conditions:

i. High Reliable Positive Information (HR_POS)
ii. High Reliable Negative Information (HR_NEG)
iii. Low Reliable Positive Information (LR_POS)
iv. Low Reliable Negative Information (LR_NEG)

Additionally, we analysed reaction time data for the mouse click response for the above four condition.

Table 1: p values for percentage news clicked as True News

Experiment 1				Experiment 2			
HR_POS	HR_NEG	LR_POS	LR_NEG	HR_POS	HR_NEG	LR_POS	LR_NEG
0.6982	0.2276	0.4985	0.3688	0.8254	0.2096	0.06334	0.9707



/ /Figure 4. Bar plots for conditions that shows trend for ingroup bias. (a) Percentage correct for low reliable positive news, (b) RT (in seconds) for high reliable positive news.

Table 2: p values for mouse click RTs

Experiment 1				Experiment 2			
HR_POS	HR_NEG	LR_POS	LR_NEG	HR_POS	HR_NEG	LR_POS	LR_NEG
0.05991	0.9613	0.3895	0.4635	0.6289	0.7575	0.9782	0.259

Discussion

In various minimal group paradigm studies, it has been shown that arbitrary categorization of individuals into arbitrary groups is sufficient to elicit ingroup favoring behaviors. In the current set of experiments, we looked at participants believability of news information when it came from differing reliability of news sources and how it interacted with the valence of the news content. It has been shown that ingroup bias

doesn’t always entail outgroup derogation, and we see this effect in the current study. Overall, the reliability of news source dominated the results, but interesting interactions were elicited with valence and grouping condition. We have a trend for ingroup positive news being more believable even if it came from low reliable source than the outgroup positive news. No other condition had significant trend for bias. Interesting insight can be drawn comparing the two studies, specifically, when participants were given as much time to deliberate and respond, the bias didn’t show up, but when the participants do the same task in speeded version, their implicit bias starts emerging. The reaction time for the second experiment didn’t have any significant interaction mostly because it was a timed response, but when the participants judged the news in deliberation for experiment 1, we see trend for ingroup bias when judging a high reliable positive news about the ingroup compared to that of the outgroup. The full data will give clearer insights to the discrepancies between our automatic biases and our overt unbiased behavior.

Self-prioritization modulates the multiple object tracking performance

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Introduction

The self-prioritization effect (SPE) is an established concept which suggests that processing of information associated with self is better than those not associated with self (Sui & Humphreys 2017). There are evidences for SPE benefits in the tasks designed to test the different processes related to attention (Sui & Humphreys 2015), perception (Sui et al., 2012), memory (Sui & Humphreys 2013), working memory (Yin et al., 2019), and decision-making (Hu et al., 2019). SPE has been found in the working memory context by Yin et al. (2019), where self-association benefits were tested for the location information, and Roy et al. (2023) have shown the processing advantages for self-associated information with location, identity, and binding of identity-location.

We wanted to test SPE in the context of working memory where Central Executive (Baddeley, 1986) continuously updates information dynamically over the duration of time.

Multiple object tracking (MOT) involves attention to track the objects and working memory to continuously update the tracked targets' information. In the MOT paradigm, location information of the objects are essential, and usually same type of objects are tracked. Multiple identity tracking (MIT) paradigm requires identities of objects for tracking. Location information of objects are sufficient for tracking when surface level information like colours, shapes etc. are involved. ¬In this study if adding social labels like self, friend and stranger are associated to coloured discs in an MOT task can affect tracking performances. We hypothesized that tracking accuracies of selfassociated and stranger-associated colored discs will be highest and lowest respectively.

Method

Participants: N=21 (Age=22.90 (4.56) | 4F, 17M). All had normal / corrected to normal vision.

Stimuli and Apparatus**:**

Association stage**:** Random mapping was used to create an association between the three colours and 'Self', 'Friend' or 'Stranger' labels, which were counterbalanced across participants. Stimuli were presented on a white background.

Main task**:** Coloured (light blue, light pink and light brown (Zhao et al., 2020)) disks for 3 set sizes (4, 8 and 12) where, half of them were targets and the other half were distractors. Cue for target identification was black colored boundary (absent during the movement phase). The coloured disk movement was confined to one grey box of size 18.2^{o} x 18.2^{o}.

Common to both stages**:** The colour disks were of size 0.96^{o} x 0.96 ^{o} on a 24" screen resolution of 1920 x 1080 with refresh rate of 60Hz. Participants were made to sit at a distance of 60 cm from the screen.

Procedure

Associative learning stage: Participants were asked to associate the colours (light blue, light pink, and light brown) to their respective social labels (i.e., 'you', 'friend', and 'stranger'). This mapping of colours to labels was counterbalanced across participants and were instructed to

remember these associations. After completing the association task, the multiple object tracking stage was started.

MOT task (Fig 1): There were 9 combinations of target-distractor colours (3 for targets and 3 for distractors) for a single set size and 3 set sizes (4,8,12). The total combinations were 27. We used 9 repetitions of all these 27 combinations. Thus, we had 243 trials, divided into 9 blocks with a break at the end of each block.

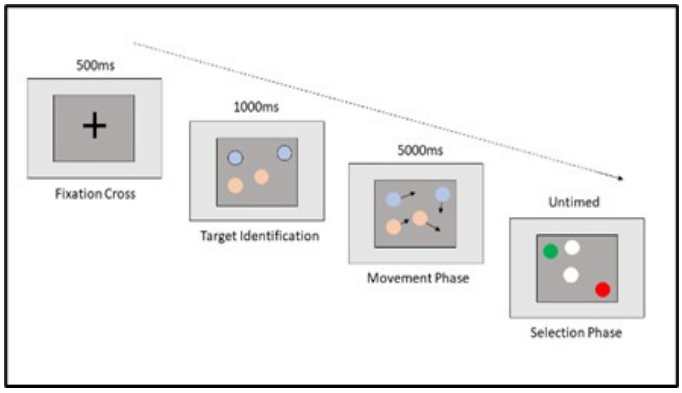

Figure 1: A single trial of the Multiple Object Tracking task.

The discs start moving simultaneously with an initial velocity of 17.2o/s, and the velocity increases or decreases by 5% with every frame till the movement ends. We added this variation in the velocity so the movement trajectory would not become predictable (Zhao et al., 2020).

The discs bounce off the edges of the central box and can pass over each other. The movement happens for 5000ms, then the discs stop, and all their colours disappear simultaneously. The participants responded using a mouse to click the targets as accurately as possible. The response windows were untimed, and they were given feedback on each selection of a trial.

Results and Analysis

Our dependent measure is each trial's recorded average Accuracy (total correct objects / total target objects). We carried out 3 (Label: Self, Friend, Stranger) x 3 (Set-size: 4,8,12) within-subjects repeated measures ANOVA for average Accuracy (Fig 2). There was a significant main effect of Label, $F(2, 40) = 4.981$, $p = 0.012$, $\eta^2_p = 0.199$ and Set-size, $F(2, 40) = 310.480$, $p < 0.001$, $\eta^2_p =$
0.939, while the interaction of Label and Set-size is also significant, $F(4, 80) = 2.931$, $p = 0.026$, $\eta^2_p = 0.128$.

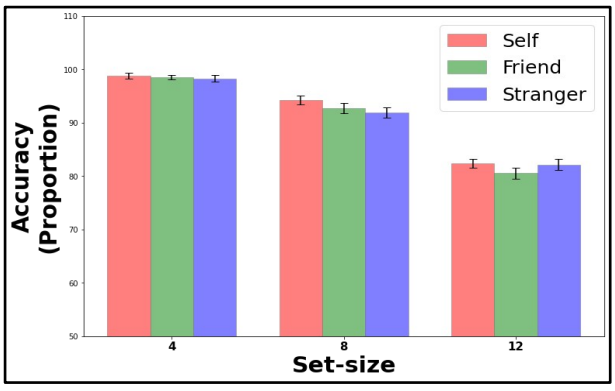

Figure 2: Mean Accuracy irrespective of distractors (error bars are 'se')

Post hoc analysis shows that the participants were significantly more accurate in tracking selfassociated coloured disks (Table 1) as compared to friend-associated coloured disks, t = 2.941, p_{holm}= 0.016 & Cohen's d = 0.324; and stranger-associated coloured disks, t = 2.463, p_{holm}= 0.036 & Cohen's d = 0.272. However, there is no significant difference in tracking performance of friendassociated coloured disks and stranger-associated disks, t = -0.479, p_{holm}= 0.63 & Cohen's d = .053.

Table 1: Mean Accuracy and SD

Set-size	Label	Mean Accuracy (Percentage)	SD (Percentage)
4	Self	98.854	2.584
	Friend	98.501	1.816
	Stranger	98.325	2.863
8	Self	94.268	3.880
	Friend	92.759	4.466
	Stranger	91.931	4.547
12	Self	82.422	3.717
	Friend	80.570	4.638
	Stranger	82.187	4.604

/

As the set-size increases, the tracking performances were significantly poorer for different Setsize. The average Accuracy for set-size 4 is significantly better than set-size 8, t = 8.093, p_{holm}< 0.001 & Cohen's d = 1.464; and set-size 12, t = 24.457, p_{holm}< 0.001 & Cohen's d = 4.423; similarly the set-size 4 average accuracy was also significantly better than set-size 12, t = 16.364, p_{holm}< 0.001 & Cohen's d = 2.959.

Discussion

In the context of multiple object tracking, constant attention is required to maintain and update the location information in the working memory. However, it needs identity information, if the identity information is task-relevant or dense. Since we used the coloured disks, the identities are only at the surface level, usually processed via parallel processing. However, we have associated this surface-level information with social labels. In principle, it should not affect the tracking performances, but it does. We found that the self-associated coloured disks were tracked better than friend-associated and stranger-associated coloured disks. The visual working memory updates the location and identity information simultaneously.

The MOT task results revealed that self-associated colors discs are significantly tracked better than friend-associated and stranger-associated discs. And tracking was significantly better for smaller set-sizes (4>8>12). We found no significant self-associated benefits for the easy task set-size 4 even though the performance for self-associated was marginally better. However, as the task becomes difficult with bigger set-size, we found clear self-association advantages. These findings suggest that in this MOT task, self-prioritization exists under challenging situations, which means self-saliency plays a role in processing once the task becomes hard enough to require more resources, but not too much hard that it breaches our general boundary capabilities like visual working memory limits.