A Project Report

On

Emotion Cognition: an Empirical Study

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Certificate

This is to certify that the project report entitled "Emotion Cognition: An Empirical Study" submitted by Ms. **Aarshia Rawat** (ID No. **2023B5AA0755H**), Ms. **Vidushi Srivastava**(ID No. **2023B5AA0800H**), Ms. **Saanvi Varma Raghavaraju** (ID No. **2023B5AA0750H**), Mr. **Adityan Singla** (ID No. **2023AAPS0198H**) in fulfillment of the requirements of the course **HSS F266**, Study Project Course, embodies the work done by them under my supervision and guidance.

Date: 11th May 2025

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ABSTRACT:

This study investigates the complex interplay between emotion regulation, cognitive functioning, and stress, with particular attention to gender differences, executive function, and lifestyle factors. Grounded in a thorough literature review on the neurobiology of emotion-cognition interactions, the research draws on evidence that cognitive and emotional processes share overlapping neural networks. Brain regions traditionally viewed as purely cognitive (e.g., dorsolateral prefrontal cortex) also regulate emotion, while emotion-related structures (e.g., amygdala) modulate cognitive tasks such as attention and memory.

Participants completed a comprehensive battery of assessments, including the Emotion Regulation Questionnaire (ERQ), Reading the Mind in the Eyes Test (RMET), Stroop Test, Digit Span Test, Trail Making Test (TMT), Corsi Block-Tapping Test, and the Modified Kuppuswamy Socioeconomic Scale (2023). Additional questionnaires assessed food habits, sleep patterns, and social behaviors.

Results revealed significant gender differences in emotion regulation strategies, with males reporting higher expressive suppression scores than females ($p = 0.003$), and no significant difference in cognitive reappraisal ($p = 0.51$). Executive function scores-specifically on TMT-B ($\beta = -0.312$, $p = 0.007$) and the Tower of Hanoi ($\beta = -0.278$, $p = 0.015$)-significantly predicted RMET performance, linking cognitive flexibility with emotion recognition. Neural network models incorporating lifestyle variables like insomnia severity and healthy eating predicted stress levels with increasing accuracy (from 57.1% to 72.2%).

These findings underscore the integrated nature of cognitive and emotional systems, suggesting that executive functioning supports social cognition, gendered socialization shapes emotion regulation strategies, and lifestyle factors critically influence stress. The study provides valuable insights into the mental health and social cognitive profiles of young adults, with potential applications for educational interventions and policy development.

INTRODUCTION:

Emotions are said to be a hammer to cognition. They significantly impact cognition, enhancing or impairing cognitive functions like attention, memory, and decision-making (Dolcos et al., 2011). Cognitive resources are limited, and emotional stimuli, due to their survival relevance, often hijack attention and interfere with goal-directed tasks (Pessoa, 2008). The brain processes emotional stimuli quickly, with the amygdala playing a central role (Vuilleumier et al., 2001; Whalen et al., 1998), but these emotions also demand attentional resources (Pessoa, 2008). The effects of emotion on cognition can be divided into two systems: Cold Executive (ColdEx), which supports goal-directed tasks via brain regions like the Dorsolateral Prefrontal Cortex, and Hot Emotional (HotEmo), which is responsible for processing emotional stimuli and allocating attention, involving brain regions such as the Amygdala and Ventromedial Prefrontal Cortex (Dolcos et al., 2011). Expressive suppression, which involves withholding emotional expression, has been found to have significant cognitive costs, such as impairing memory, attention, and decision-making (Szczygieł & Maruszewski). Chronic emotional suppression introduces physiological changes in the sympathetic nervous system and elevates vasoconstriction causing stress-like symptoms (Peters et al., 2014). Which can further affect the brain's motivation and cognitive control areas including Nucleus Accumbens and Anterior Cingulate Cortex- brain's go getter circuitry (Astori & Sandi), impairing cognitive regulation and emotional memory encoding (Katsumi & Dolcos). Sleep quality is another important factor in the emotion-cognition relationship, as it has been shown to influence emotional regulation and cognitive functioning. REM sleep, in particular, supports emotional regulation through enhanced limbic activity (Vandekerckhove et al., 2017), and lifestyle factors can mediate the relationship between emotion regulation and sleep quality (Ning et al., 2024). Gender differences in emotion regulation are evident, as women tend to show greater emotional reactivity and expressiveness, engaging more emotion-processing regions like the Amygdala and Orbitofrontal Cortex (Pritschet et al., 2024). These differences in emotional processing and regulation can also be influenced by social conditioning and learned strategies.

Neurobiological Background:

Although historically viewed as separate functions, with Emotions linked to ancient limbic structures (e.g., amygdala) and Cognition associated with newer cortical regions (e.g., dlPFC), this dual model has been challenged by modern neuroimaging and electrophysiological research, revealing many shared neural networks between emotion and cognition and their influence on each other. Brain regions previously thought to be solely cognitive, like the dlPFC, are crucial for emotional tasks, such as reappraisal and threat processing. Similarly, the amygdala modulates attention and interacts with the prefrontal cortex, affecting memory and decision-making. Emotional stimuli capture attention through subcortical networks, and emotional states (e.g., anxiety) can bypass cognitive filters, impairing working memory. Emotion regulation also involves cognition, with attention-based strategies activating prefrontal regions to downregulate amygdala activity. In contrast, phobics may show reflexive avoidance without conscious control, maintaining high amygdala activity. Studies highlight that cognition and emotion share circuits, particularly in the prefrontal cortex. Okon-Singer et al. (2015) suggest that regions like the dlPFC and midcingulate cortex (MCC) are critical for both emotion regulation and cognitive tasks. The dlPFC helps manage emotional distractions, while the MCC adjusts attention and goal-directed behavior. Emotional distress can influence brainstem neurotransmitter systems, altering the signal-to-noise ratio in cortical areas. Emotion and cognition emerge from large-scale brain networks, with regions like the dlPFC, ACC, and insula engaged depending on context, task demands, and internal state. Feedback loops exist, where adaptive loops (e.g., dlPFC regulating amygdala) support goal-directed behavior, while maladaptive loops (e.g., overactive amygdala) impair control, reinforcing distress. Our brains are shaped by experience and neuroplasticity, influenced by early life stress, personality, and hormones. Modern neuroscience shows that emotion and cognition are governed by interconnected brain regions, with tools like brain imaging and machine learning uncovering these networks.

Emotion Suppression:

Our emotions deeply shape our reality and how we deal with them shape our inner world- impacting both our minds and cognitive abilities. One strategy to navigate human life, Expressive Suppression, involves holding back the expression of what is truly felt on the inside and “has been found to increase tension” (Szczygieł & Maruszewski). Although this response might be socially expected and conditioned in many settings, depending on it too often has serious cognitive and neurological costs.

A research done by (Astori & Sandi) highlights that the Nucleus Accumbens (NAc) and Anterior Cingulate Cortex (ACC), areas involved in motivation and executive control, are particularly vulnerable to stress. In fact, “chronic stress disrupts the connections” in this circuit, leading to a weakened motivation state and impaired cognitive regulation (Astori & Sandi). Along the same lines, emotional repression contributes to “stress-related physiological responses,” and prolonged stress “is known to impair cognitive performance, such as memory, attention, and decision-making” (Patel & Patel). Stress allocates the brain’s attention resource toward perceived threats, “often at the expense of other executive functions” like planning or problem-solving or attention or memory(Pessoa).

On a deeper level, Emotional Suppression also affects processing of emotional memories. It’s known to “reduce amygdala activity” and “disrupt functional connectivity critical for emotional memory encoding” (Katsumi & Dolcos). While this can sometimes help individuals-especially those with limited cognitive resources, such as in depression-suppression also interferes with the amygdala-hippocampus interaction, a core pathway in emotional learning (Katsumi & Dolcos).

Gender and Emotion Regulation:

Historically and culturally the differences between emotional regulation strategies cross gender have been acknowledged. Recent research by Drs. Laura Pritschet, Emily Jacobs, and Elizabeth Chrastil (Nature Neuroscience, 2024; NIH summary) showed that pregnancy could be responsible for expressive and hormone-driven changes in the female brain, mainly the reduced gray matter that is essential for emotion and social processing, and increased white matter. These changes, are non a vivid occurrence in non-pregnant women or in men, and thus suggest that the female brain adapts during pregnancy to enhance and improve emotional sensitivity and social cognition traits that could prove to be crucial for motherhood although it is often observed that of the cognitive abilities like memory temporarily decline. Such results show how female-specific biological events can lead to unique patterns of emotion regulation and cognitive adaptation, deepening and expanding our understanding of gender differences in these domains.
Studies have found that women generally show greater emotional reactivity, expressiveness, more extensive knowledge of emotional experiences and better recall of emotional autobiographical memories. These differences are reflected in neural activity, especially in the amygdala and orbitofrontal cortex (OFC), across multiple domains.
A critical finding in the paper is the sex-specific lateralization in the basolateral amygdala (BLA) during emotional memory processing - women show left-lateralized amygdala activity while men show right-lateralized amygdala activity. Important points to be noted are that this lateralization occurs specifically in the BLA, not the dorsal amygdala, appears only for delayed memory and is not observed for immediate memory recognition. There are two complementary explanations presented in the paper for this -
Women tend to employ verbal/local strategies during emotional encoding and men typically use visual-spatial/global strategies
Lateralization of amygdala activity during emotional memory encoding may depend on the interaction between the perceiver and the characteristics of the stimulus. For instance, left-sided amygdala activation is more common when women process female faces, while right-sided activation is observed when men process male faces-a pattern consistent with the “same-sex face” hypothesis. This suggests that social familiarity, gender-based perceptual strategies, and cultural roles, rather than biological sex alone, may influence how emotional memories are processed and stored.
Sex differences extend to emotion regulation strategies-
Neural recruitment patterns - women primarily recruit emotion processing regions (amygdala, OFC) whereas men primarily recruit cognitive processing regions (PFC)
Reappraisal effectiveness - men show greater decreases in amygdala activity with less prefrontal effort while women show greater ventral striatal activity (suggesting positive affect generation), this suggests men may regulate emotions with less cognitive effort while women may leverage positive affect to downregulate negative emotions

Habitual Regulation strategies - reappraisal correlates with positive personal memories in men while suppression correlates with negative with negative personal memories in women. Thus, findings suggest that emotional processing differences between sexes stem from a complex interplay of biological factors, social conditioning and learned regulatory strategies, affecting how emotions are experienced, processed and remembered.

Hypotheses:

In this study, we investigated various factors related to stress and emotion regulation. Our hypotheses were as follows:

- ***H1:*** Gender differences exist in emotion regulation strategies, particularly in the use of expressive suppression.
- ***H2:*** Higher executive function abilities (e.g., planning and cognitive shifting) predict better emotion recognition ability.
- ***H3:*** Emotion regulation and lifestyle variables (e.g., insomnia, eating habits) significantly predict stress levels.

METHODOLOGY:

Setting:

Data was collected in the span of 2 days, April 18th and April 19th, 2025 in Birla Institute of Technological Sciences, Hyderabad. Psychological tests were conducted in multiple (4 to 5) quiet rooms, with each room having maximum 4 participants, spread out in each corner so as to not disturb the other participants. Each room had 4 “invigilators” to help guide the participants and to ensure smooth flow of the tests, with each invigilator catering to mainly one participant. All participants signed an informed consent form approved by the institutional ethics committee. The participants were not shown test scores in order to prevent anxiety and misinterpretation.

Participants:

Patients (N=69) from Birla Institute of Technological Sciences, Hyderabad participated in the study, composed mainly of students pursuing Bachelors in Engineering along with or without a Masters in Science. Out of 69 patients, 3 didn’t complete all the tests and were filtered out. They were probably apprehensive about the tests and/ or their self perception of their performance. In some cases they might just have some urgent business to attend to. Some of them urged for test scores to be shown, but invigilators were specially instructed to not share any results, with all the scores submitted by invigilators in a Google form.

Procedure:

Participants filled an online self-attested questionnaire on Google Forms using their devices. After that they were instructed and made to complete the following tests (Stroop Test, Tower of Hanoi

(N=4), Digit Span test, Corsi Block Test, RMET) on the invigilators' laptops and did TMT A and B using a pen and paper with invigilator noting down the time taken. , measured using a stopwatch or a mobile device. The time was noted down after the test was completed, not in front of the participants. For the RMET test, participants were first given a list of all the emotions which will appear in the test and given time to go through them to understand. Then they did the test on the device, along which they could refer to the sheet in between.

Tests used:
Each of the tests used provided insight into use of various brain areas.

1. *Emotion Regulation Questionnaire (ERQ):*

- Assesses: Cognitive reappraisal and expressive suppression strategies.
- Main brain areas: Dorsolateral prefrontal cortex (dlPFC), ventromedial prefrontal cortex (vmPFC), and amygdala. The dlPFC and vmPFC are implicated in implementing and maintaining reappraisal strategies, while the amygdala is involved in generating and modulating emotional responses.

2. *Reading the Mind in the Eyes Test (RMET):*

- Assesses: Theory of Mind and social-emotional inference.
- Main brain areas: Superior temporal sulcus, anterior temporal cortex (temporal pole), and inferior frontal gyrus. These regions are involved in interpreting social cues and attributing mental states to others.

3. *Stroop Color and Word Test:*

- Assesses: Cognitive control, attentional inhibition, and conflict monitoring.
- Main brain areas: Anterior cingulate cortex (ACC) and dorsolateral prefrontal cortex (dlPFC). The ACC detects conflict, while the dlPFC is critical for exerting top-down control to resolve interference.

4. *Digit Span Test (Forward):*

- Assesses: Working memory capacity and manipulation.
- Main brain areas: Dorsolateral prefrontal cortex (dlPFC) for manipulation and maintenance, and parietal lobes for storage and sequencing.

5. *Trail Making Test (TMT-A & B):*

- Assesses: Visual attention, processing speed (A), and cognitive flexibility, task-switching (B).
- Main brain areas: TMT-A primarily engages the parietal cortex and premotor areas for attention and sequencing. TMT-B additionally recruits the dlPFC and superior parietal lobule for set-shifting and executive control.

6. *Corsi Block-Tapping Test:*

- Assesses: Visuospatial working memory.
- Main brain areas: Right posterior parietal cortex and dorsolateral prefrontal cortex, which are crucial for spatial attention and memory span.

7. *Tower of Hanoi:*

- Assesses: Planning, problem-solving, and executive functioning.
- Main brain areas: Dorsolateral prefrontal cortex (dlPFC) for planning and sequencing, and anterior cingulate cortex (ACC) for monitoring and error detection.

8. *Lifestyle & Habit Questionnaire (food, sleep, social life*):

- Assesses: Behavioral and lifestyle factors rather than direct brain function.
- Main brain areas: Not directly mapped, but lifestyle factors like sleep and stress are known to modulate activity in the prefrontal cortex, amygdala, and ACC, influencing emotion-cognition interactions.

9. *Modified Kuppuswamy Socioeconomic Scale:*

- Assesses: Socioeconomic status (SES).
- Main brain areas: Not directly linked to specific brain regions, but SES is associated with differences in brain development and function, especially in the prefrontal cortex and limbic system due to environmental influences.

RESULTS:

Table 1. Independent sample t-test

Group	N	Mean	SD	t	df		p-value
Male	49	37.0	10.4			ERQ_Cognitive	
Female	20	35.3	7.7	0.662	67		0.51
Male	49	24.1	7.7			ERQ_Expressive	
Female	20	18.1	6.2	3.094	67		0.003

Keys: ERQ- Emotion Response Questionnaire;

Table 2. Regression

Dependent Variable:	Predictors	beta	t-Value	p-Value	df	F-value	P-value	R-square
RMET	TMT_B	-0.312	-2.799	0.007	2	7.53	,001	0.186
	TOH	-0.278	-2.499	0.015	66			

Correlations

		Happiness	wellbeing	ERQ_Expressive	ERQ_Cognitive	SAdness	Annoyance	PSS
Happiness	Pearson Correlation	1	.537**	-.192	.078	-.621**	-.239*	-.355**
	Sig. (2-tailed)		.000	.114	.524	.000	.048	.003
	N	69	69	69	69	69	69	69
wellbeing	Pearson Correlation	.537**	1	-.041	-.019	-.598**	-.077	-.406**
	Sig. (2-tailed)	.000		.736	.880	.000	.530	.001
	N	69	69	69	69	69	69	69
ERQ_Expressive	Pearson Correlation	-.192	-.041	1	.174	-.096	-.238*	-.137
	Sig. (2-tailed)	.114	.736		.152	.431	.049	.262
	N	69	69	69	69	69	69	69
ERQ_Cognitive	Pearson Correlation	.078	-.019	.174	1	-.143	-.337**	-.148
	Sig. (2-tailed)	.524	.880	.152		.240	.005	.224
	N	69	69	69	69	69	69	69
SAdness	Pearson Correlation	-.621**	-.598**	-.096	-.143	1	.336**	.588**
	Sig. (2-tailed)	.000	.000	.431	.240		.005	.000
	N	69	69	69	69	69	69	69
Annoyance	Pearson Correlation	-.239*	-.077	-.238*	-.337**	.336**	1	.383**
	Sig. (2-tailed)	.048	.530	.049	.005	.005		.001
	N	69	69	69	69	69	69	69
PSS	Pearson Correlation	-.355**	-.406**	-.137	-.148	.588**	.383**	1
	Sig. (2-tailed)	.003	.001	.262	.224	.000	.001	
	N	69	69	69	69	69	69	69

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The tables and the correlation table have interesting implications and observations. Table 1 shows that using t test, with respect to ERQ Cognitive, there aren't significant differences between genders but for ERQ Expressive, there is a significant (p=0.003) difference across genders with Males scoring less than Females. This suggests that Males are more likely to suppress their emotion expression.

Table 2 shows regression done for RMET scores based on Tower of Hanoi moves or TMT-B time. Interestingly, both have negative beta values i.e. a negative slope, indicating that a higher score in RMET roughly translates to a lower score in the other, especially for TMT-b with p value p=0.007.

The Correlation Table shows the correlation coefficient between different scores obtained in the questionnaire for different parts. As expected, we can see a positive correlation between Happiness and wellbeing, and a significant negative correlation between happiness and sadness. We also see a significant positive correlation between Annoyance and Sadness. Interestingly, we also see a significant negative correlation between Annoyance and ERQ-Cognitive, indicating more annoyed people and less likely to perform well in ERQ cognitive. One possible reason can be due to annoyance clouding thinking and making them score less, or having less cognitive abilities in general leading to annoyance in a competitive environment like an engineering college.

DISCUSSION:

Gender Differences in Emotion Regulation: Suppression vs Reappraisal:

Research by Cai et al. (2016) explored gender differences in expressive suppression and found that men, especially ambiverts, showed greater neural suppression (measured via late positive potentials) than women during unpleasant image viewing. This difference was not fully captured by self-report data, suggesting suppression may function automatically in men due to cultural socialization.

In our study, male participants reported significantly higher expressive suppression scores ($p = 0.003$) than females, with no difference in cognitive reappraisal ($p = 0.51$). These results align with Cai et al.'s findings, supporting the hypothesis that suppression is more habitual and culturally reinforced in males.

Executive Functioning Predicts Emotion Recognition Accuracy:

Milojevich and Lukowski (2016) demonstrated that children with stronger executive functions performed better on emotional understanding tasks, particularly in identifying emotions from facial cues. This supports the broader view that cognitive flexibility and planning aid in processing emotional information.

Our data revealed that Trail Making Test-B (TMT-B) and Tower of Hanoi (TOH) scores significantly predicted Reading the Mind in the Eyes Test (RMET) performance, with $\beta = -0.312$ ($p = 0.007$) for TMT-B and $\beta = -0.278$ ($p = 0.015$) for TOH. The negative beta for TMT-B suggests that better shifting ability (lower time) correlates with stronger emotion recognition. These results reinforce the hypothesis that executive function underpins social cognition even in young adults.

CONCLUSION:

This study aimed to deepen our understanding of how emotion regulation, cognitive flexibility, and stress interact, focusing on the influence of gender, executive function, and lifestyle factors in young adults. Our findings pointed at notable gender differences in emotion regulation strategies: males reporting higher expressive suppression, whereas no significant gender difference in cognitive reappraisal was found. Executive function, measured by the Trail Making Test-B and Tower of Hanoi, quite accurately predicted emotion recognition ability (i.e. the RMET score); thus, highlighting the role of cognitive flexibility and planning in social cognition.

Moreover, our neural network models demonstrated that lifestyle factors such as sleep quality and healthy eating habits are meaningful predictors of perceived stress, although model performance indicated that stress is a multifactorial construct requiring broader assessment. These results collectively demonstrate that emotion and cognition are not separate segments but are deeply interconnected, sharing overlapping neural networks brain regions responsible for these phenomena; and being shaped by both intrinsic (e.g., executive function, gender) and extrinsic (e.g., lifestyle, socioeconomic status) influences. The study contributes meaningful insights about individual differences in emotion regulation and cognitive flexibility and their relation to social cognition and stress. Aligning with our objectives, the study highlights the importance of considering lifestyle and contextual factors in mental health research and intervention design.

Limitations and scope of improvement: This study was conducted on a relatively small and homogenous sample of 69 college students, with only 66 valid responses included in the final analysis. Because all participants came from the same academic institution, they likely shared similar socioeconomic backgrounds, academic pressures, and cultural environments. This limited diversity reduces the generalizability of the findings to broader or more varied populations. Emotional regulation was measured through self-reported questionnaires, which may be influenced by personal bias, social desirability, or misinterpretation of items. The neural network analysis was based on only two variables, healthy eating and insomnia scores, which may not fully capture the complexity of stress and its relationship with cognitive and emotional functioning. Additionally, there appeared to be an imbalance in the distribution of stress group classifications, which led the models to favor one group and perform poorly on the others, affecting the overall accuracy and reliability of classification.

Future Scope: Future studies should include larger and more diverse samples across different institutions to enhance the generalizability of results. Expanding the range of lifestyle and psychosocial variables, and incorporating objective measures alongside self-reports, would allow a more comprehensive understanding of the emotion-cognition-stress relationship. Additionally, improving model balance and feature diversity could enhance the accuracy of predictive analyses.