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RESEARCH ARTICLE

An Integrative Approach to Emotional Assessment in Postgraduate Medical Students: Combining AI-Driven Emotion Detection with Conventional Psychological Scales

Dr. Gopal Shinde[1], Dr Sushant Bhadane[2], Sandeep Pendurkar[3], Saurabh S. Shaligram[4], Dr. Pritesh Kothari[5], Dr. Suhas Patil[6], Dr. Chaitanya Bhujbal[7], Dr. Pani Jaya Nivetha JR[8], Yashashree Joshi[9] and Sai Sanjana Chitturi[10]

[1]Professor / Department of Orthopaedics, MPGIMER, MUHS, Nashik,
[2]Professor/ Dept of Radiodiagnosis, MPGIMER, MUHS, Nashik
[3]Business Director, Nihilent Ltd, Pune
[4]Principal Data Scientist, Nihilent Ltd, Pune
[5]Assoc. Professor Orthopaedics MPGIMER, MUHS, Nashik
[6]Asso. Professor Paediatrics, MPGIMER, MUHS, Nashik
[7]JR1 Orthopaedics, MPGIMER, MUHS Nashik
[8]Radiodiagnosis, MPGIMER, MUHS Nashik
[9]Senior Software Engineer Nihilent Ltd, Pune
[10]Assoc. Product Manager, Nihilent Ltd, Pune

*Corresponding Author
Saurabh Shaligram
(saurabh.shaligram@nihilent.com)

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Abstract: Emotional awareness is a crucial yet often neglected aspect of integrative health. Within medical education, emotional well-being frequently receives the lowest priority despite its critical role in sustaining psychological stability, cognitive performance, and interpersonal functioning. This becomes especially important during postgraduate medical training, when academic, clinical, and personal pressures peak. With advancements in Artificial Intelligence (AI) and Machine Learning (ML), novel emotion AI platform, Emoscape offers innovative ways to measure emotional states, in addition to traditional psychological instruments like the Beck Anxiety Inventory (BAI) and the Perceived Stress Scale (PSS). This study evaluates the emotional responses of postgraduate medical students to various academic and personal challenges using Emoscape's AI-based emotion detection. By integrating, near real-time emotion data, the study aims to identify key emotional burdens and propose evidence-based interventions to enhance emotional balance as part of a broader integrative health paradigm.

Keywords: Emotional awareness, Integrative health, Artificial Intelligence (AI), Postgraduate medical training, Emotion detection

INTRODUCTION

Integrative health emphasizes the interconnectedness of physical, mental, emotional, and social well-being. Emotional states profoundly influence physiological processes, stress regulation, cognitive function, and overall quality of life. Chronic emotional dysregulation is associated with increased allostatic load, impaired immunity, and heightened risk of non-communicable diseases (Sapolsky, 2004) [5]. In medical education, these effects are amplified by the intensity of training and the responsibility of patient care.

Postgraduate medical students face substantial academic pressure, heavy clinical workloads, and expectations of professional competence. These stressors contribute to elevated anxiety, emotional instability, and burnout, which may impair learning and compromise patient outcomes.

Traditionally, tools such as the Beck Anxiety Inventory (BAI) and the Perceived Stress Scale (PSS) have been used to assess self-perceived anxiety and stress among Post Graduate Medical Students. However, such instruments rely on subjective reporting and may not fully capture nuanced emotional fluctuations.

The emergence of AI-driven emotion detection offers a new frontier in emotional assessment. By integrating Emoscape, an emotion AI platform grounded in India's ancient Navarasa framework. This study aims to present a multi-dimensional model of emotional health in medical students—bridging ancient emotion science, modern psychology, and advanced technology.

METHODOLOGY

Seventy-one postgraduate medical students enrolled in MD programs participated in this phase of the study. Informed consent was obtained, and all protocols adhered to ethical research standards.

Assessment Tools:

1. Emoscape – An AI-ML platform that analyses upper-body micro-movements in near real time using a web camera, mapping them to the nine Navarasa emotions and two derived dimensions (stress and engagement)

2. Beck Anxiety Inventory (BAI) – A validated psychological instrument for assessing the severity of anxiety symptoms.
3. Perceived Stress Scale (PSS) – A widely used self-report measure for evaluating perceived stress.

Procedure:
Participants completed the BAI and PSS questionnaires administered by a psychiatrist to establish baseline anxiety and stress levels. Subsequently, their emotional responses were recorded using Emoscape during various academic and personal contexts—including lectures, clinical duties, examinations, and rest periods. Emotional states were mapped across the Navarasa spectrum and correlated with stress and engagement levels.

What is Emoscape?
Emoscape is the world's finest Emotion AI platform developed by Nihilent Ltd, capable of detecting and interpreting emotions in near real time through upper-body micro-movements. Rooted in the Navarasa, the nine classical emotions described in the Natyashastra, Emoscape uses 3D motion capture and machine learning algorithms to provide fine-grained emotional insights. It is fully non-invasive, requiring no wires, sensors, or manual input, only a web camera, making it highly adaptable for use across healthcare, education, sports, marketing, corporate well-being, and more.

The nine emotions Emoscape captures are expressed in Sanskrit, each represented across a nuanced spectrum [1]:

- Śṛṅgāra (Love/Attachment) – from affection to deep emotional attachment.
- Hāsya (Happiness/Joy) – from mild contentment to exuberant delight.
- Raudra (Impatience/Anger) – from irritation to intense rage.
- Karuṇa (Pensiveness/Sadness–Empathy) – from gentle sorrow to profound compassion.
- Vīra (Pride/Drive/Courage/Ego) – from motivation, determined resilience to ego.
- Bhayānaka (Fear/Anxiety) – from unease, worry to overwhelming fear.
- Bībhatsa (Disgust/Aversion) – from mild dislike to strong repulsion.
- Adbhuta (Surprise/ active thinking) – from curiosity to heightened wonder and active thinking.
- Śānta (Calm/Peace) – from momentary stillness to deep equanimity.

By grounding modern Emotion AI in the timeless science of the Navarasa, Emoscape offers a culturally rooted yet globally relevant approach to understanding human emotions in near real time.

Stress is modelled as a dynamic state derived from the interplay of these nine emotions, which can be adaptive and positive in certain scenarios or negative and taxing in others.

The study by Daudelin-Peltier et al. (2017) demonstrates that under acute social stress, individuals exhibit increased sensitivity to surprise and decreased sensitivity to disgust, indicating a significant shift in emotional perception. [11] These findings can be meaningfully linked to the classical Indian aesthetic concepts of ādhbhūta (wonder or surprise) and vibhāsta (disgust or revulsion), where heightened recognition of surprise reflects an amplified ādhbhūta rasa, and diminished recognition of disgust corresponds to a suppression of vibhāsta rasa. Thus, stress can be understood and indirectly measured through the dynamic interplay of these two rasas, highlighting how acute social stress modulates emotional processing by enhancing responses to novel, unexpected stimuli while dampening sensitivity to aversive, distancing emotions.

Data Collection Procedure and Analysis
Participants were asked to complete both the BAS and PSS questionnaires to quantify their anxiety and stress levels. Simultaneously, emotional responses were captured using Emoscape in various academic and personal scenarios, such as during lectures, clinical duties, examinations, and rest periods. These emotional responses were categorized into key emotional states like anxiety, sadness, frustration, calmness, and positivity.

Aggregated Analysis
To ensure a holistic understanding of participants' emotional states:

- Data from all three tools (Emoscape, BAS, and PSS) were **aggregated and analysed collectively**.
- **Cluster analysis** was performed to group students based on similar emotional response patterns and stress profiles.
- The analysis helped identify **common emotional triggers**, such as examination periods, night duties, and interpersonal conflicts.
- Comparisons were made across demographics (e.g., year of study, gender) to evaluate any significant variations in emotional well-being.
- The findings were visualized using **heatmaps and emotional trend graphs** to highlight high-stress periods and dominant emotional states.

This integrated approach enabled a multi-dimensional perspective on student well-being, combining subjective reporting (BAS, PSS) with near real-time emotional monitoring (Emoscape).

Average Emotional Scores of Participants

This analysis presents the **aggregated scores based on emoscape test reports** of MD students. It aims to assess the collective emotional well-being of the group and identify signs of stress, burnout, or emotional fatigue

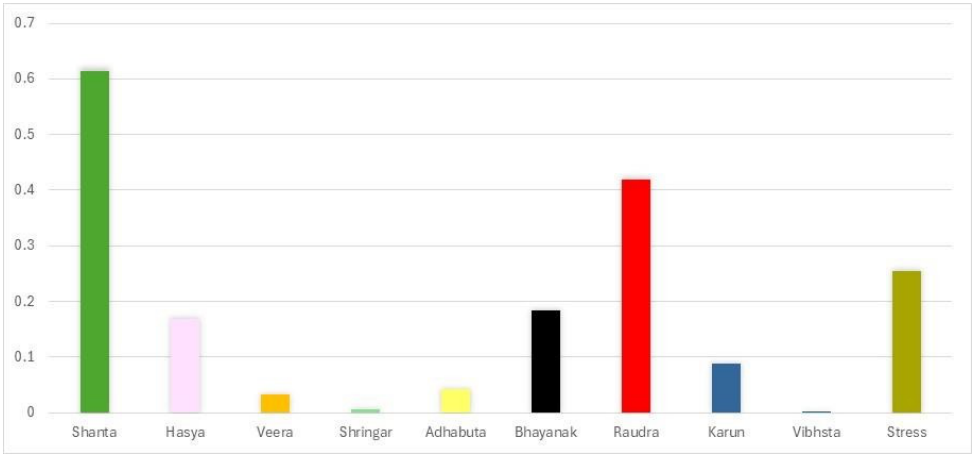


Figure 1Avg

Key Insights

- Outward Calm, Inward Conflict Students show a calm exterior (Shanta) but internally experience elevated stress and anger (Raudra, Bhayanaka).
- Signs of Burnout and Emotional Fatigue Emotional exhaustion is evident through low levels of joy, motivation, and curiosity.
- Compassion Fatigue Compassion (Karuna) levels are lower than expected for healthcare professionals, indicating early emotional detachment.
- Emotional Regulation at a Cost While emotional self-control is present, it may be leading to emotional suppression rather than true resilience.

Department wise Emotional Scores of Participants

This analysis explores emotional patterns across medical departments using focusing on *Shanta*, *Hasya*, *Bhayanak*, *Raudra*, and *Karun*. By applying clustering techniques, departments are grouped based on their dominant emotional profiles. The results highlight distinct emotional climates, from high-pressure procedural roles to calm, analytical, or compassion-driven specialties.

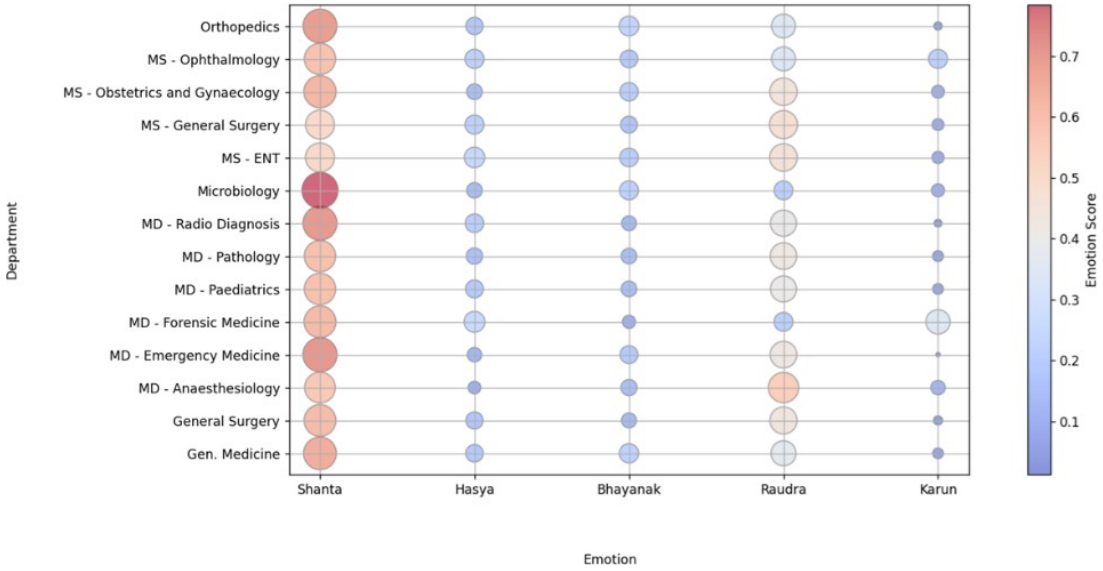


Figure 2 Dept

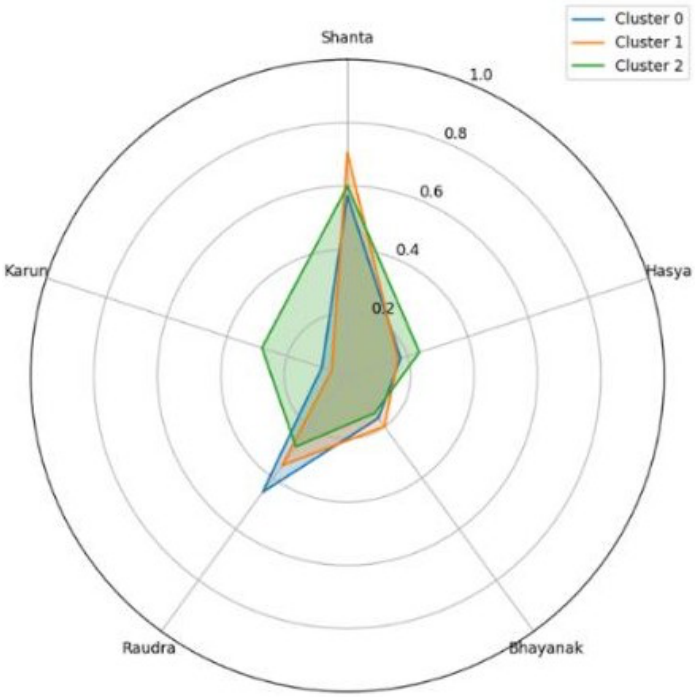


Figure 3 Average Emotional Profile per Cluster

Cluster Observations

Cluster	Departments	Key Traits	Emotional Profile
0	Surgery, Anaesthesiology, ENT, Gynae, etc.	High Raudra, Moderate Bhayanak, Low Karun	High-stress, procedural
1	Gen. Medicine, Emergency, Ortho, Radio Dx, Microbiology	High Shanta, Low Karun, Low Hasya	Detached, calm, analytical
2	Forensic Medicine, Ophthalmology	High Karun, Lower Raudra	Compassionate & emotionally engaged

Key Insights

- **Technical/Lab fields** show peace but may lack compassion.
- **Surgical departments** show elevated anger and low peace.
- **Forensic and Ophthalmology** uniquely express both sorrow and humour.
- **Emergency Medicine** is calm but emotionally detached.

Exploratory Cluster Analysis of Emotional States

This section outlines the motivation and rationale behind using emotional clustering to understand student emotional patterns. It introduces the Navarasa emotional model, modern stress indicators, and the significance of analysing emotion data using machine learning.

Why K Means?

In this study, K-means clustering was employed as the core analytical method to process and interpret emotional data collected from 130 students, each of whom underwent a minimum of six emotional assessments, resulting in over 780 individual test records. To uncover meaningful patterns within this complex dataset, K-means was selected for its efficiency, scalability, and ability to work with high-dimensional emotional variables.

K-means clustering is an unsupervised machine learning algorithm used to partition a dataset into K non-overlapping clusters. Each cluster is characterized by its centroid—the mean of all data points within the cluster. The algorithm iteratively minimizes the intra-cluster variance (how similar members of a cluster are to each other) and maximizes inter-cluster distinction using the objective function:

$$J = \sum_{i=1}^{K} \sum_{x \in C_i} \|x - \mu_i\|^2$$

Where:

- x is a data point
- μ_i is the centroid of cluster C_i [14]

Given the multidimensional nature of emotional data, including traditional Navarasa emotions (e.g., Shanta, Raudra, Bhayanaka) along with modern constructs like stress, K-means provides a powerful and interpretable way to detect emotional archetypes across the student population.

In this analysis, the algorithm successfully identified five distinct clusters, each representing a unique emotional and psychological profile, allowing for deeper insights into how students regulate, experience, and express emotions over time.

Clustering Outcome

The K-means clustering algorithm analysed a large emotional dataset collected from 130 students, each of whom underwent multiple tests, resulting in over 780 emotional assessments. From this analysis, the algorithm identified five distinct clusters, each representing a unique emotional archetype—a recurring emotional signature that reflects how individuals tend to experience, regulate, and express emotions.

These clusters were not manually defined but emerged naturally from the emotional patterns in the data. They were based on combinations of traditional Navarasa emotions (e.g., Shanta, Raudra, Karuna, Hasya, Bhayanaka, Veera) along with a modern variable: stress.

Each cluster captures a different balance or tension among these emotions—whether it's suppressed anger beneath calm, or empathy paired with quiet anxiety. These patterns reflect underlying psychological states, coping mechanisms, and emotional tendencies.

Important Note:

Because students participated in multiple tests over time—and because emotional states naturally fluctuate—a single student may appear in more than one cluster across different moments. This dynamic clustering reflects how emotional experiences are context-sensitive and time-dependent rather than fixed traits.

In other words, these clusters represent emotional *states*, not rigid personality types. A student might align with the "Controlled Volcano" archetype during a stressful week, and with the "Compassionate Observer" in a calmer, more empathetic context.

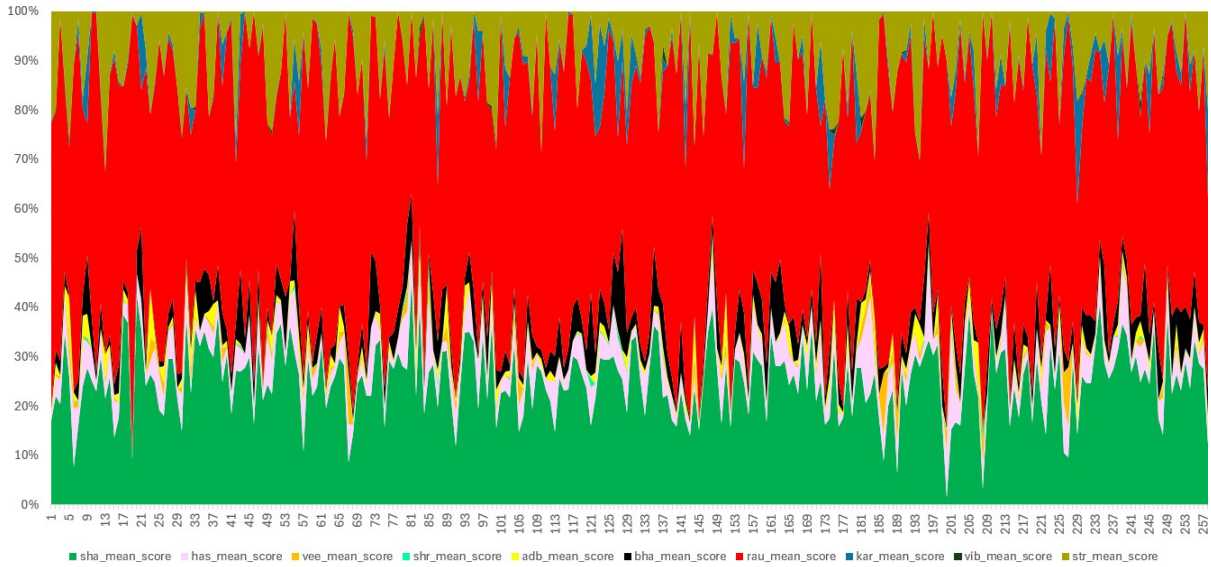
What Each Cluster Includes:

Each cluster is described using the following elements:

- **Dominant Emotions**: The primary emotions (from Navarasa + stress) that define the cluster.
- **Emotional Profile**: A narrative explanation of how these emotions interact in real life.
- **Core Psychological Themes**: The behavioural and cognitive patterns linked to the emotion mix.
- **Possible Psychological States**: Specific mental/emotional states with:
    - **Descriptions**
    - **Traits**
    - **Risks or vulnerabilities**
    - **Academic or clinical references**
- **Implications**: How this emotional profile might affect a student's well-being, learning, or social interaction.

This approach offers a data-driven yet psychologically grounded framework for understanding the emotional diversity within student populations. It can guide educators, counsellors, and researchers in designing emotion-aware interventions, personalized learning plans, and mental health strategies that honour the emotional complexity of each student.

Cluster 1 Controlled Volcano



Dominant Emotions:

- Raudra: 0.82
- Shanta: 0.44
- Stress: 0.19

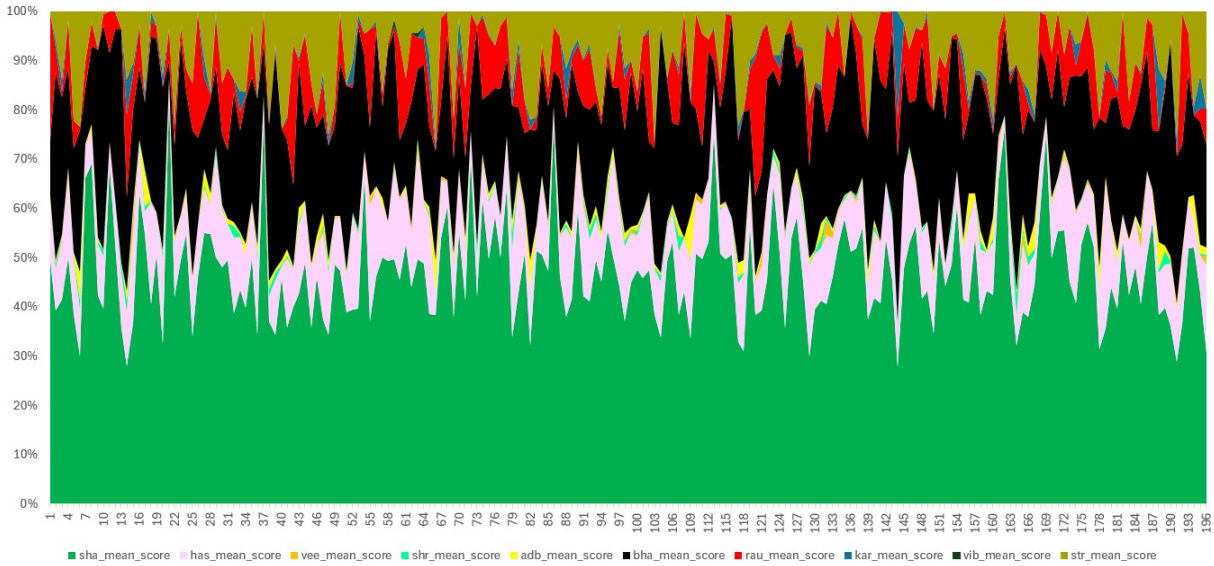
Emotional Profile:
An individual experiencing **strong internal anger** or moral intensity (Raudra) but striving to maintain **calm** and **control** (Shanta). Stress arises from the ongoing effort to suppress or regulate emotional intensity.

Core Theme: Suppressed intensity masked by composure — high risk for burnout or emotional fatigue.

Possible psychological states:

State	Description	Traits	Risks	Reference
Suppressed Anger	Anger held back due to internal restraint	Frustration, tension, emotional restraint	Passive-aggression, emotional fatigue	Gross (1998) [2]
Emotional Containment	Intense emotion managed silently	Stoic, composed, internalize	Somatic symptoms, disconnection	Linehan (1993) [12]
Controlled Assertiveness	Anger channelled constructively	Leadership, principled action	Rigidity, lack of emotional flexibility	Bandura (1997) [8]
Burnout Risk	Chronic tension without release	Withdrawn, irritable	Depression, disengagement	Maslach & Leiter (1997) [3]

Cluster 2: The Calm Alarm



Dominant Emotions:

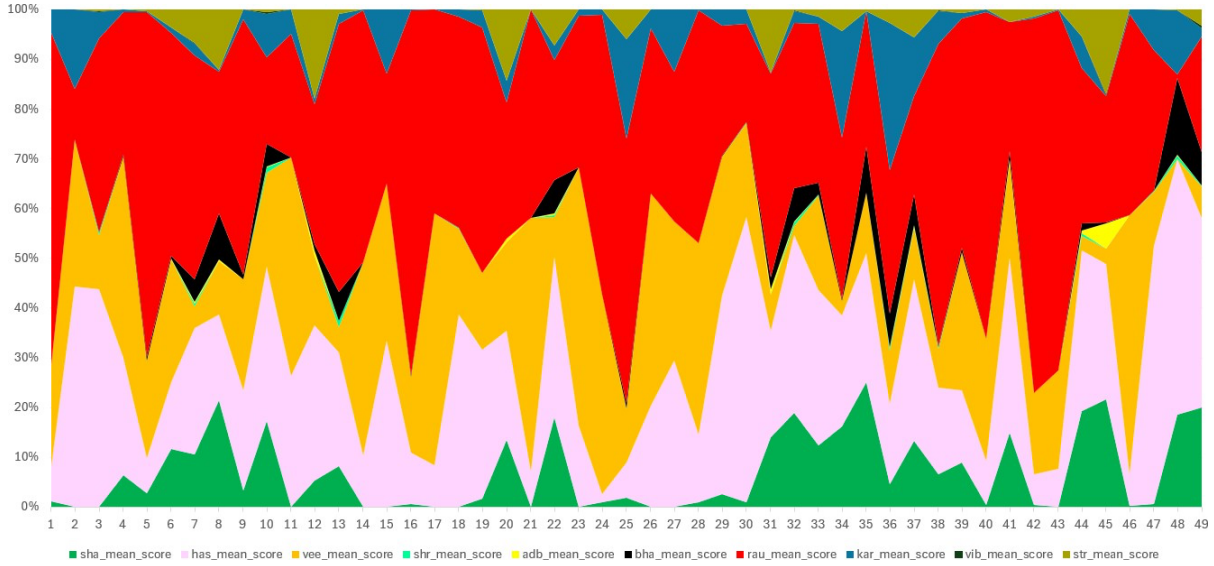
- Shanta: 0.81
- Bhayanaka: 0.43
- Hasya: 0.20
- Stress: 0.17

Emotional Profile:
A person maintaining external calm while internally navigating **mild anxiety**, **fear**, and **stress**, softened with a light sense of humour (Hasya).

Core Theme: Grace under pressure — poised on the outside, tense beneath the surface.

State	Description	Traits	Risks	Reference
High-Functioning Anxiety	Appears capable but struggles internally	Perfectionist, overthinker	Burnout, insomnia	Cain (2012) [13]
Cognitive Dissonance	Conflicting internal emotions	Tension, indecisiveness	Emotional fatigue	Festinger (1957) [9]
Mindful Avoidance	Uses humour to soften stress	Reflective, emotionally distanced	Avoids deeper processing	Kabat-Zinn (1990) [10]

Cluster 3 The Strategic Firebrand



Dominant Emotions:

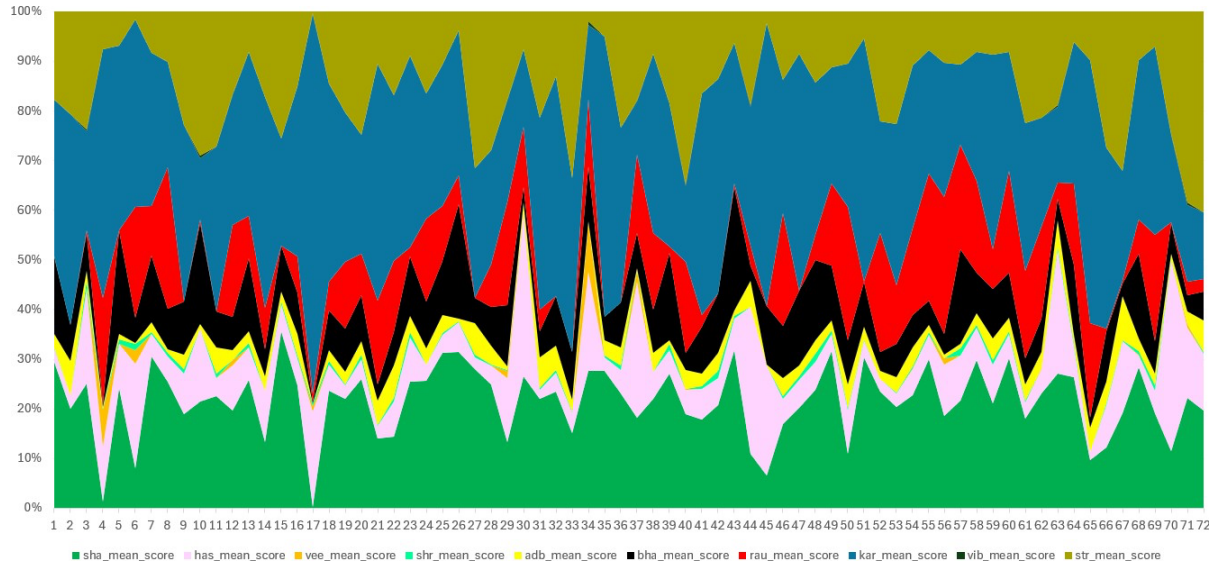
- Raudra: 0.60
- Hasya: 0.39
- Veera: 0.34
- Shanta: 0.12

Emotional Profile:
An energetic, bold individual who uses humour and courage to drive action, often with high intensity and assertiveness.

Core Theme: Charismatic disruptor — passionate, witty, action-oriented.

State	Description	Traits	Risks	Reference
Moral Assertiveness	Anger aligned with values	Direct, courageous	May alienate others	Haidt (2001) [4]
Controlled Aggression	Strategic emotional force	Leader-like, assertive	Outbursts if unchecked	Gross (1998) [2]
Humour as Coping	Emotion regulation through wit	Witty, charming	Superficiality	Martin (2003) [6]

Cluster 4: The Compassionate Observer



Dominant Emotions:

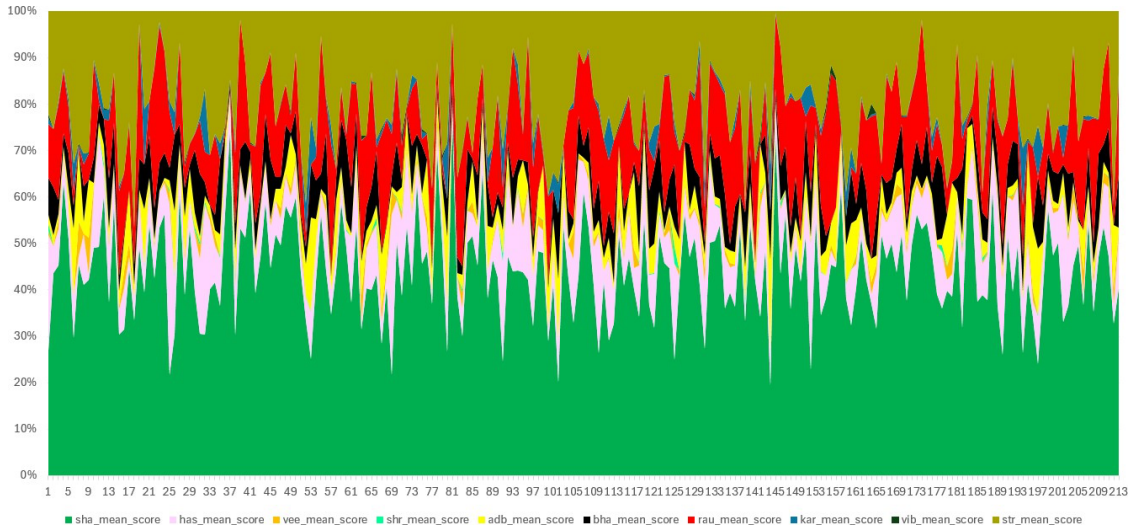
- Karuna: 0.63
- Shanta: 0.45
- Bhayanaka, Raudra, Hasya: Low

Emotional Profile:
A deeply **empathetic** and **emotionally aware** person who processes minor emotional disturbances with introspection and quiet strength.

Core Theme: Emotions in balance — quietly managing the pain of others and the self.

State	Description	Traits	Risks	Reference
Empathic Stability	Compassion + calm	Warm, nurturing	Neglects self	Neff (2003) [7]
Subtle Emotional Suppression	Mild anger/fear unspoken	Sensitive, reserved	Low-level tension	Gross (1998) [2]
Quiet Stress Response	Carries pain silently	Introspective, composed	Somatic symptoms	Sapolsky (2004) [5]

Cluster 5 The Tense Peacemaker



Dominant Emotions:

- Shanta: 0.79
- Stress: 0.42
- Raudra: 0.41
- Bhayanaka, Hasya: Low

Emotional Profile:
Externally calm but internally balancing **stress**, **mild anger**, and **fear**, with minimal humour. Often appears stoic but emotionally conflicted.

Core Theme: Silent endurance — calm on the surface, emotionally heavy beneath.

State	Description	Traits	Risks	Reference
Emotional Suppression	Anger and fear held in	Composed, serious	Emotional fatigue	Gross (1998) [2]
Chronic Stress Response	Suppressed conflict builds up	Quiet, vigilant	Burnout	Sapolsky (2004) [5]
Passive Assertiveness	Conflict-avoidant self-control	Understated, indirect	Misunderstood	Linehan (1993) [12]

DISCUSSION

This integrated approach underscores the central role of emotions in integrative health. Emotional dysregulation in medical students manifests both subjectively (via anxiety and stress scales) and physiologically (via micro-movement patterns). With the objective, scalable and easy to use, Emoscape based assessments, educators and clinicians can gain a richer, near real-time emotional map to detect early signs of distress, burnout, or emotional detachment.

Furthermore, cultural frameworks like Navarasa offer a uniquely context-sensitive emotional vocabulary, enhancing both interpretability and acceptance in educational and clinical settings.

CONCLUSION

Emotions are not peripheral to health—they are foundational. This study demonstrates that emoscape based emotion detection provides a powerful, integrative method for assessing emotional well-being in postgraduate medical students. Such approaches can inform early interventions, promote resilience, and foster emotionally aware medical professionals. Future phases of this research will explore Yog Nidra as a guided relaxation intervention to restore emotional balance and reduce stress.

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