Research Article

www.ijrap.net

(ISSN Online:2229–3566, ISSN Print:2277–4343)

EXPLORING THE RELATIONSHIP BETWEEN NEUROPSYCHOLOGICAL BIOMARKERS AND LEARNING PACE: A COMPARATIVE STUDY OF SLOW AND FAST LEARNERS INTEGRATING AYURVEDA COGNITIVE DOMAINS

Pavneet Kaur [1]*, Nithin Krishnan R [2]

[1] PG Scholar, Department of Roga Nidana Evum Vikriti Vigyana, Shri Dhanwantry Ayurvedic College and Hospital, Chandigarh, India

[2] Associate Professor, Department of Roga Nidana Evum Vikriti Vigyana, Shri Dhanwantry Ayurvedic College and Hospital, Chandigarh, India

Received on: 07/8/25 Accepted on: 22/9/25

***Corresponding author**
E-mail: drkaurpavi11@gmail.com

DOI: 10.7897/2277-4343.165173

ABSTRACT

Background: In Ayurveda, Manas (mind) governs cognition by transmitting sensory input from Gyanindriyas (sense organs) to the brain, comparable to afferent neural transmission in modern neuroscience. Ayurveda cognitive domains Chintyam (deliberative thinking), Vicharyam (critical examination), Uhhyam (inferential-predictive thinking), Dhyeyam (focused contemplation), Sankalpyam (decision making), and Buddhi Pravartate (higher intellect) offer a distinctive view of mental functions. Objective: To examine the relationship among cognitive function, perceived stress, and learning pace among undergraduates using neuropsychological tools and Ayurveda Variables. Methods: This cross-sectional observational study included 17 students aged 18–25. Learners were categorized as fast or slow based on Periodic assessments PA1 and PA3. Cognitive function was measured using the Mini-Mental State Examination (MMSE), and stress levels with the Perceived Stress Scale (PSS-10). Data were analysed using Jamovi 2.6.2. Results: Fast learners showed higher MMSE scores than slow learners, with a large effect size (Cohen's d = 0.95), though not statistically significant (p = 0.174), likely due to the small sample size. PSS scores differed minimally (Cohen's d = 0.29, p = 0.572). A significant association was found between lower MMSE scores and slower learning pace ($p < 0.001$). No correlation was noted between MMSE and PSS-10 (r = 0.015, p = 0.954), suggesting stress did not influence the cognition learning link. Discussion: Cognitive function appears more closely linked to learning pace than stress. Integrating Ayurveda cognitive domains with neuropsychological tools offers a culturally relevant framework for future educational research.

Keywords: Cognitive domains, MMSE, PSS-10, Learning Efficiency

INTRODUCTION

Cognitive neuroscience emphasizes the early detection of specific learning difficulties and the development of neuropsychopedagogical strategies aimed at strengthening or rehabilitating targeted cognitive domains.[1] Humans' unique self-awareness, coupled with the brain's extended developmental window up to the age of 25, makes early education a critical period for cultivating neuroplasticity, the brain's ability to reorganize itself by forming new neural connections in response to experience.[2] This supports the rationale of the present study, which applies classical principles to evaluate cognitive and stress related markers in academic performance.

Ayurveda conceptualizes cognitive functions through the integrative view of Manas (mind) -Vishaya (objectives of mind) and Karma (function of mind) reflects Ayurveda's holistic understanding of cognitive science.[3,4,5] [Table 1]. Disturbances in this system, such as Mano Vibhrama (cognitive distortion) and Buddhi Vibhrama (intellectual distortion), represent dysfunctions of the mind and intellect, negatively affecting thinking, decision-making, and altering overall cognitive functions[6]. These disturbances contribute to abnormal thinking patterns, including obsessions and cognitive distortions, which influence cognitive attributes such as Buddhi (intellect), Samgnana (perception), and Smruti (memory)[7].

The Mini-Mental State Examination (MMSE) is widely used as a measure of general cognitive functioning. Both the Brazilian Academy of Neurology and the American Academy of Neurology recommend the MMSE as a general cognitive screening tool for detecting dementia in individuals with suspected cognitive impairment.[8] Equivalently, perceived stress occurs when environmental demands exceed an individual's ability to cope with them.[9] The impact of stress on cognitive abilities depends on how individuals perceive stressful situations and the specific cognitive functions being examined. The perception of stressful events is assessed using the Perceived Stress Scale (PSS-10). Population-based studies have shown that a higher perceived stress is associated with lower cognitive functioning and a faster rate of cognitive decline.[10]

Objectives

The objectives of the study are to classify undergraduate's students into fast and slow learners based on academic periodic assessment scores, to assess cognitive functions using the Mini-Mental State Examination (MMSE) scores, to measure perceived stress using the Perceived Stress Scale (PSS-10) scores, and to examine the association among cognitive function, stress, and learning efficiency through both Ayurveda and neuropsychological variables. The aim of the study is to examine how perceived stress alters the functioning of manas, resulting in Mano Vibhrama (cognitive distortions) and Buddhi Vibhrama (intellectual distortions), which affect the learning efficiency of students.

Hypothesis

Null Hypothesis (H_0): Cognitive impairment is not significantly associated with poorer learning outcomes, regardless of stress levels.

Alternative Hypothesis (H_1): Cognitive impairment is significantly associated with poorer learning outcomes, independent of stress levels.

MATERIALS AND METHODS

Study Design and Setting

This pilot study is a cross-sectional observational investigation conducted at a single point in time. The assessment session was held on 10-02-2025 from 12:00 to 1:00 PM at the institute premises.

Inclusion Criteria

The study included undergraduate students aged 18 to 25 years who had completed both the PA1 and PA3 periodic academic assessments. Participants of any sex who voluntarily agreed to participate were enrolled after providing electronic informed consent through a Google Form, ensuring that consent was obtained per ethical standards and participant autonomy was respected. Eligible participants completed the PSS-10 through the online platform via Google Form and underwent the MMSE in person, administered by the investigator during scheduled sessions.

Exclusion Criteria

Participants were excluded if they were absent during either PA1 or PA3 periodic academic assessments, failed to complete the PSS-10 or MMSE sessions, or declined to participate. Individuals with a history of diagnosed psychiatric disorders (such as depression, anxiety, or schizophrenia), neurological conditions (including epilepsy or history of significant head trauma), or those currently on psychotropic medications were excluded to minimize confounding variables. Additionally, participants using substances that may affect cognition or mood (e.g., alcohol, sedatives) or those with chronic systemic illnesses potentially influencing cognitive function (such as uncontrolled diabetes or hypertension) were excluded. Non-compliance with study procedures or inability to complete required assessments also resulted in exclusion from the final analysis.

Ethical consideration

Informed consent was obtained from all participants before questionnaire administration. Participants were assured of the confidentiality of their responses and the anonymity of their identities throughout the study.

Variables

This study examined the relationship between cognitive function, perceived stress, and learning pace, incorporating both modern neuropsychological tools and Ayurveda cognitive Variables. Cognitive function and perceived stress were the primary outcome variables, serving as the main indicators for analyzing cognitive and emotional functioning in the student population. The main exposure variable was learning pace, defined using academic performance in two periodic assessments (PA1 and PA3). Students scoring above the calculated mean in both assessments were categorized as fast learners, while those scoring below the mean were classified as slow learners. This binary classification enabled exploration of how cognitive and stress related variables relate to academic pace. The study also incorporated Ayurveda cognitive attributes as predictor variables to bridge Ayurveda concepts with modern neuropsychological outcomes. A detailed mapping of these Ayurveda variables with neuropsychological parameters is provided in [Tables 1-3]. Potential confounding variables included age, sex, and baseline academic performance. These variables were identified due to their independent influence on cognitive and stress-related outcomes. For instance, age is a known factor in cognitive capacity, sex-based differences may influence stress perception and cognitive strategies, and prior academic performance could confound the interpretation of learning pace. Additionally, perceived stress was hypothesized as a potential effect modifier, with the possibility of mediating or moderating the relationship between cognitive function and academic performance. It was posited that higher stress levels might reduce the effective utilization of cognitive resources, thereby affecting learning pace. All variables, including demographic data, MMSE scores, PSS-10 scores, and academic performance, were collected and included in the analysis to ensure a comprehensive evaluation of predictors and outcomes.

Data sources and measurement

Standardized tools (MMSE and PSS-10) were used to evaluate cognitive performance and perceived stress levels. Both instruments have been widely used in Indian and global populations, with established psychometric reliability and validity in previous studies. The tools were administered in their original English versions. The MMSE consists of 12 items covering orientation, recall, attention, language, and visuospatial skills, with a maximum score of 30. Scores of 26–30 are considered normal, 25-20 indicate mild, 19-10 moderate, and 9-0 severe cognitive impairment.[11] It was originally designed to detect dementia in older adults, but is now widely utilized across various age groups, including young adults, for diverse research purposes. Supporting this, A large Brazilian study involving 1,553 healthy individuals, including 559 young adults aged 20-40, demonstrated the MMSE's sensitivity in capturing cognitive variation among younger adults, supporting its application in non-geriatric populations.[6] It has also demonstrated robust clinical validity and improved scoring consistency, with high inter and intra-reliability. Its diagnostic accuracy is further supported by an ROC value of 0.94 in competency evaluation studies.[12] Perceived stress was designed to measure individuals' appraisal of stress over the past month. The scale consists of 10 items, with total scores ranging from 0 to 40. PSS-10 scores are obtained by adding the responses to the six negatively stated items (items 1, 2, 3, 6, 9, 10) and reversing the responses to the four positively stated items (items 4, 5, 7, 8), using the following conversion: 0 = 4, 1 = 3, 2 = 2, 3 = 1, and 4 = 0. The final score is the sum of all 10 items. Based on the total score, stress levels are categorized as low (0-13), moderate (14-26), and high (27-40). The tool has been validated in multiple Indian studies involving young adults aged 18-25, including undergraduate and medical students. The PSS-10 to detect elevated stress levels during COVID-19 induced social isolation, showing notable gender-based differences in stress perception.[13] The scale is effective in capturing significant stress variation among medical students based on access to digital e-learning resources.[14] Its utility by exploring correlations between perceived stress and coping strategies among college students, establishing the scale's construct and ecological validity in academic stress contexts.[15], thereby establishing the scale's construct and ecological validity. Learning pace categorization was based on academic performance data obtained from institutional records of PA1 and PA3 assessments, accessed with appropriate administrative approval and conducted under standardized examination protocols. Demographic variables such as age and sex were collected using a self-administered demographic form prior to testing and were considered potential confounders in the analysis. All assessments were conducted in a single session under identical testing conditions to ensure methodological comparability between fast and slow learners.

Bias

The multiple control strategies implemented to reduce their effects are outlined in [Table 4]. These actions were undertaken to improve the accuracy and trustworthiness of the study results.

Study size justification

The study included 17 undergraduate students from a single academic batch, selected based on predefined inclusion criteria and voluntary participation. The sample was chosen for feasibility and to explore trends in neuropsychological parameters across learner groups (based on PA1 and PA3 scores), serving to inform future, larger-scale research.

Statistical methods

Statistical analyses were conducted using Jamovi software (version 2.6.2). Descriptive statistics (mean, median, and standard deviation) were used to summarize demographic characteristics and outcome variables, including cognitive function (MMSE) and perceived stress (PSS-10) scores. Group comparisons (fast vs. slow learners; normal cognition vs. mild cognitive impairment) were performed using independent samples t-tests, and Cohen's d was calculated to assess effect size. Pearson's correlation coefficient was used to evaluate the relationship between cognitive and stress scores. One-way ANOVA was conducted to compare cognitive scores across different stress categories. Chi-square tests were used to assess the association between learning type and cognitive status. All analyses were two-tailed, and a p-value < 0.05 was considered statistically significant.

RESULTS

Participants

The study included 17 undergraduate students, 2 males (11.8%) and 15 females (88.2%), aged 18 to 25 years (Mean age = 20.7 years, SD = 1.1), selected from an initial pool of 100 students. A total of 40 students were excluded due to absence during periodic assessments PA1 and PA3. To classify participants based on academic performance, scores from PA1 and PA3, each graded out of 15 marks, totalling 30 marks per student, were analyzed. The mean score (10.27) was calculated from the 60 students who completed both assessments and served as the threshold for categorization. Participants scoring 10.27 or higher were classified as fast learners (n = 30), while those scoring below 10.27 were categorized as slow learners (n = 30). For representative sampling, the 10 highest-scoring students from the fast learner group and the 10 lowest-scoring students from the slow learner group were selected, yielding a final intended sample of (n= 20) students. After accounting for participant availability, (n=17) students completed the study and were included in the final analysis [Figure 1].

Outcome Data

Fast learners had a higher average MMSE score (M = 28.4, SD = 1.98) compared to slow learners (M = 26.1, SD = 2.79), though this difference did not reach statistical significance (t = 1.43, p = 0.174) [Tables 5-6]. Participants with mild cognitive impairment (n = 2) had a mean MMSE score of 20.0, significantly lower than those with normal cognition (M = 27.8, SD = 1.72), with the difference being statistically significant (t = -5.79, p < 0.001) [Table 6]. The effect size was large (Cohen's d = 0.95), indicating a strong association between cognitive status and MMSE scores [Table 7]. Based on the PSS-10 scores, most participants experienced moderate perceived stress (n = 13), while three had low stress and one had high stress [Table 5]. The average PSS-10 score was slightly higher among fast learners (M = 22.7, SD = 6.13) than among slow learners (M = 20.9, SD = 6.28), but this difference was not statistically significant (t = 0.578, p = 0.572) [Table 6]. Similarly, participants with mild cognitive impairment reported a marginally higher average stress score (M = 22.5, SD = 3.54) compared to those with normal cognition (M = 21.4, SD = 3.67), but this was not significant (t = 0.449, p = 0.660) [Tables 5-6]. The effect size for stress differences across cognitive groups was small (Cohen's d = 0.29) [Table 7].

Other analysis

Correlations and Subgroup Analysis

There was no significant correlation between MMSE scores and PSS-10 scores (Pearson's r = 0.015, p = 0.954), indicating no linear association between stress and cognitive function in this sample [Table 8]. Subgroup analyses further revealed no significant differences in MMSE or PSS-10 scores between fast and slow learners (p = 0.174 and p = 0.572, respectively), nor were there significant differences across stress categories [Table 9]. The cognitive profile differed slightly by learning pace, as both students with cognitive impairment were slow learners; however, this difference was not statistically significant (p = 0.110).

Sensitivity Analysis

The sensitivity analysis explored whether stress influenced cognitive scores or learning pace. Neither stress category (low/moderate/high) nor total PSS-10 scores significantly impacted MMSE outcomes (p = 0.756 and p = 0.954, respectively), indicating that perceived stress was not a confounder in this study [Table 10].

Interpretation and Contextualization

The findings support long standing evidence that cognitive attributes such as attention, memory, and executive function are core determinants of academic performance. The findings suggest that cognitive function, as assessed by MMSE, plays a role in learning pace, though the difference between fast and slow learners was not statistically significant (p = 0.174) [Table 6]. Although stress was expected to impact learning pace, no significant difference in stress levels was found between groups (p = 0.572) [Table 6]. This may indicate that stress is a universal factor among students, affecting both fast and slow learners equally. Furthermore, perceived stress did not mediate the relationship between cognitive function and learning pace (p = 0.954) [Table 10], suggesting that cognitive ability is a more direct predictor of learning efficiency. This supports the Ayurveda concept of Indriyabhighraha (sensory control) and Manasah Svasyanigraha (self-control), which enhance cognitive stability regardless of external stressors. The strongest finding was the correlation between cognitive impairment and poor learning outcomes (p < 0.001) [Tables 6 and 9], reinforcing the importance of cognitive abilities in academic success [Tables 6-7]. Ayurveda principles suggest that impairments in Dhyeyam (focused contemplation) and Sankalpyam (decision-making) could contribute to decreased academic performance.

Table 1: Ayurveda Variables and Modern Correlation and Interpretation

Ayurveda Variables	Modern Cognitive Function	Examples
Chintyam (deliberative thinking)	Executive Function and Decision Making	Ethical dilemmas, strategic choices
Vicharyam (Critical examination)	Logical Reasoning and Problem-Solving valid reasoning and invalid or contradictory reasoning	Scientific analysis, research evaluation
Uhhyam (Inferential -Predictive Thinking)	Probabilistic Thinking, logically predicts outcomes from existing clues, reasoning, and assumptions. Forecasting	Stock market predictions, risk assessment
Dhyeyam (focused Contemplation)	Meditation, Mindfulness, awareness and Deep Learning	Goal setting, meditative concentration
Sankalpyam (Decision making)	Value Judgment and Risk Analysis	Cost-benefit analysis, moral decision-making
Yat Kinchid (Implicit cognitive processes)	Emotional Intelligence and Unconscious Bias	Recognizing emotions, managing stress
ManasoJneyam (Mind-dependent knowledge)	Abstract Thinking and Intuition	Creativity, philosophy, self-reflection
Indriyabhighraha (Sensory Regulation)	Sensory Integration and Environmental Awareness	Processing stimuli, maintaining focus amid distractions
Manasah Svasyanigraha (Self-Control)	Emotional Self-Control and Resilience	Delayed gratification, regulating emotional outbursts
Uha (Logical Deduction)	Abstract Inference and Symbolic Processing	Interpreting metaphors, planning responses to hypothetical situations
Vichara (Critical Evaluation)	Adaptive Reasoning and Problem Solving	Multi-step planning, evaluating competing outcomes
Buddhi Pravartate (Higher intellect)	Integrated Cognition, Insight and Wisdom	Holistic decision-making, life purpose reflection

Table 2: Correlation with Mini Mental Status Examination (MMSE) Parameters

Ayurveda Variables	Cognitive Function	MMSE Parameter
Chintyam (deliberative thinking)	Memory (Short-Term and Long-Term)	Recall, Registration
Vicharyam (Critical examination)	Cognitive Processing and Executive Function	Attention and Calculation (Serial 7s or Spelling Backwards)
Uhhyam (Inferential -Predictive Thinking)	Judgment and Abstract Thinking	Orientation, Reasoning (e.g., Interpreting a Proverb)
Dhyeyam (focused Contemplation)	Sustained Attention and Working Memory	Concentration, Following Commands
Sankalpyam (Decision Making)	Executive Function and Planning	Writing and Copying (Interlocking Pentagons)
Indriyabhighraha (Sensory Regulation)	Sensory Integration and Perception	Visuospatial Skills
Manasah Svasyanigraha (Self-Control)	Impulse Control and Emotional Regulation	Behavioural Observations
Uha (Logical Deduction)	Problem-Solving and Abstract Thinking	Naming Objects
Vichara (Critical Evaluation)	Reasoning and Decision-Making	Following Three-Step Commands
Buddhi Pravartate (Higher intellect)	Overall Cognitive Integration	Overall MMSE Score Interpretation

Table 3: Correlation with Perceived Stress Scale-10 (PSS-10) Parameters

Ayurveda Variables	Cognitive Function	PSS-10 Parameter
Chintyam (deliberative thinking)	Cognitive Overload and Worry	"In the last month, how often have you felt nervous and 'stressed'?"
Vicharyam (Critical examination)	Perceived Control Over Situations	"In the last month, how often have you felt that you were unable to control important things in your life?"
Uhhyam (Inferential -Predictive Thinking)	Ruminative Thinking	"In the last month, how often have you found that you could not cope with all the things you had to do?"
Dhyeyam (focused Contemplation)	Cognitive Overload and Task Management	"In the last month, how often have you found yourself thinking about things that you have to accomplish?"
Sankalpyam (Decision Making)	Self-Efficacy and Problem Solving	"In the last month, how often have you felt confident about your ability to handle personal problems?"
Indriyabhighraha (Sensory Regulation)	Emotional and Sensory Processing	"In the last month, how often have you been upset because something happened unexpectedly?"
Manasaḥ Svasyanigraha (Self-Control)	Emotional Regulation and Resilience	"In the last month, how often have you felt that you were on top of things?"
Uha (Logical Deduction)	Coping Strategies and Resilience	"In the last month, how often have you been angered because of things that were outside of your control?"

Vichara (Critical Evaluation)	Cognitive Flexibility and Adaptability	"In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?"
Buddhi Pravartate (Higher intellect)	Overall Coping and Stress Perception	Overall PSS Score Interpretation

Table 4: Bias in the study

Type of Bias	How it was Addressed or Controlled
Selection Bias	Minimized by applying clear inclusion/exclusion criteria based on academic performance (PA1 and PA3). All eligible students were considered from the same academic batch.
Measurement Bias	Reduced by using two validated tools: MMSE (Mini-Mental State Examination) and PSS-10 (Perceived Stress Scale). Administration was done in a single session by the same trained evaluator.
Recall Bias	Minimized in the PSS-10 by limiting recall to the past one month, as per the standard tool instructions.
Observer Bias	Reduced by classifying students into fast and slow learners based on objective academic records rather than evaluator judgment.
Participation Bias	Addressed by ensuring voluntary participation, maintaining anonymity, and creating a stress-free environment during assessments to encourage honest responses.
Sample Bias	Acknowledged as a limitation: small sample size (n=17) and gender imbalance (majority female) may limit generalizability.
Blinding	Not implemented due to the small scale of the study. However, consistent instructions and administration procedures were used to minimize variability and personal bias.

Table 5: Descriptive Statistics

Variable	Group	N	Mean	Median	Standard Deviation (SD)
Total Participants	All	17	–	–	–
Age (years)	All	17	Not specified	–	–
Gender	Male	2	–	–	–
	Female	15	–	–	–
Learner Category	Fast Learners	9	–	–	–
	Slow Learners	8	–	–	–
MMSE (Cognitive Marks)	Fast Learners	9	28.4	28	1.98
	Slow Learners	8	26.1	27	2.79
MMSE	Normal Cognition	15	–	–	–
	Mild Cognitive Impairment	2	–	–	–
PSS (Stress Score - Total Score)	Fast Learners	9	22.7	22	6.13
	Slow Learners	8	20.9	21	6.28
Stress Rating	High Perceived Stress	1	–	–	–
	Moderate Perceived Stress	13	–	–	–
	Low Perceived Stress	3	–	–	–
Total Score vs. Cognitive Type	Mild Cognitive Impairment (2)	2	22.5	22.5	3.54
	Normal Cognition (15)	15	21.4	21	3.67
Cognitive Marks vs. Cognitive Type	Mild Cognitive Impairment (2)	2	20.0	20.0	0.00
	Normal Cognition (15)	15	27.8	28	1.72

Table 6: T-Test Results and Interpretation

Comparison	Test Type	t-statistic	p-value	Interpretation
Total Stress Score (Above vs. Below Average learners)	Independent t-test	0.578	0.572	No significant difference in stress scores based on performance.
Total Stress Score (Mild Cognitive Impairment vs. Normal Cognition)	Independent t-test	0.449	0.660	No significant difference in stress scores between cognitive groups.
Cognitive Score (Mild Cognitive Impairment vs. Normal Cognition)	Independent t-test	-5.79	<0.001	Significant difference in cognitive scores between cognitive groups.
Cognitive Score (Above vs. Below Average learners)	Independent t-test	1.43	0.174	No significant difference in cognitive scores based on performance.

Table 7: Cohen's d: Effect size analysis

Variable	Cohen's d	Effect Size Interpretation
MMSE (Cognitive)	0.95	Large
PSS (Stress Score)	0.29	Small

Table 8: Correlation Matrix Results and Interpretation

Variables	Pearson's r	p-value	95% CI (Lower, Upper)	Interpretation
Total Stress Score and Cognitive Score	0.015	0.954	(-0.469, 0.492)	No significant correlation between stress scores and cognitive scores.

Table 9: Subgroup Analysis

Subgroup Variable	Category	Outcome Measured	Key Findings
Learner Category	Fast (n=9) vs. Slow (n=8)	MMSE, PSS	No significant difference in MMSE (p=0.174) or PSS (p=0.572) between groups.
Cognitive Type	Normal Cognition vs. Mild Cognitive Impairment	MMSE	Significant difference in MMSE ($p < 0.001$); mild impairment linked to slow learners.
Stress Rating	Low, Moderate, High	MMSE, PSS	No significant difference across stress categories (MMSE p=0.756; PSS p<0.001)
Gender	Female (n=15), Male (n=2)	Not analyzed due to skew	Too small a male sample to draw meaningful inference.

Table 10: Sensitivity Analysis (Impact of Confounding)

Tested Relationship	Potential Confounder	Analysis Method	Findings
MMSE vs. Learning Efficiency	PSS (Stress Score)	Pearson Correlation	No significant correlation (r = 0.015, p = 0.954) – stress is not a mediator.
MMSE vs. Stress Rating	Stress Category (Low–High)	ANOVA	No significant impact of stress level on cognitive score (p = 0.756)
Learning Type vs. Cognitive Type	Cognitive Impairment	Chi-square test	2 Slow learners had impairment; no fast learners did (p = 0.110)
Total PSS Score vs. Cognitive Type	Cognitive Impairment	T-Test	Not statistically significant (p = 0.660)

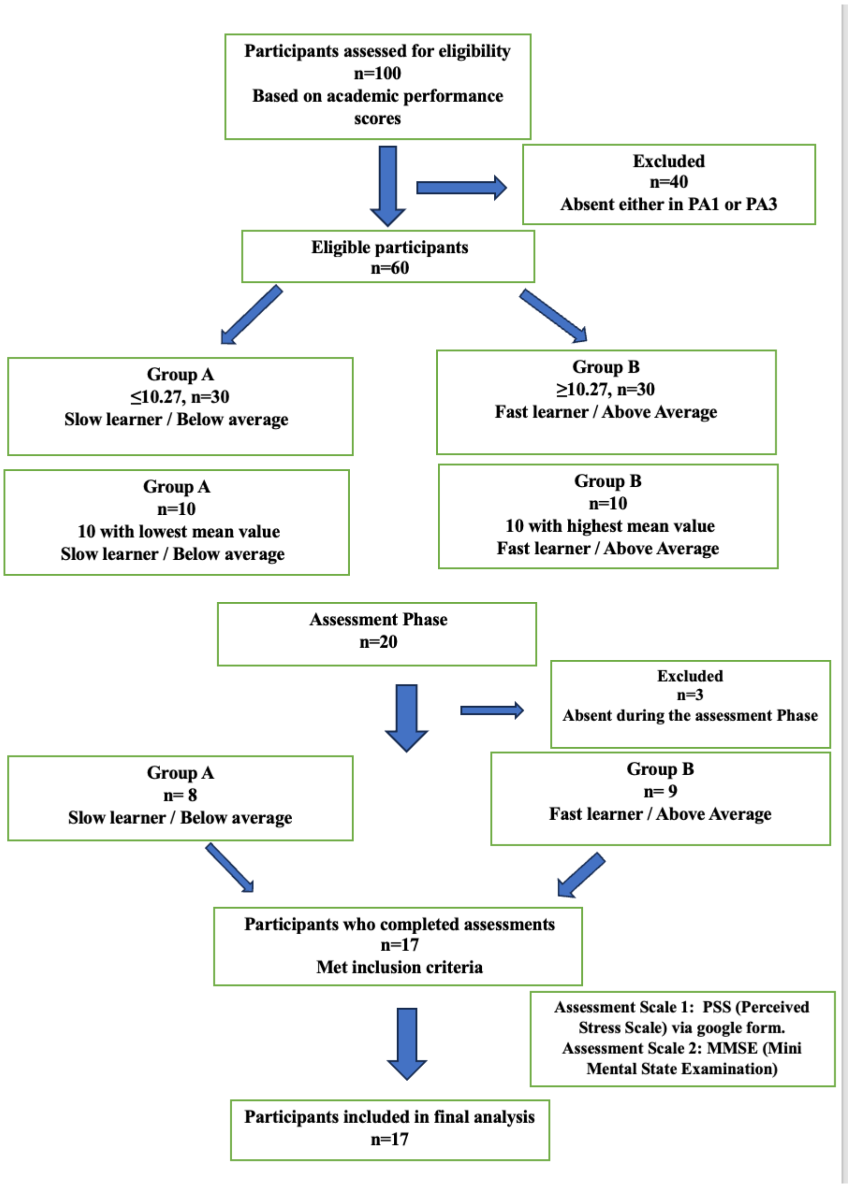

Figure 1

DISCUSSION

Limitations

Despite its strengths, this study is limited by several methodological constraints. The small sample size of 17 participants restricts statistical power and may contribute to non-significant p-values in group comparisons. Moreover, the gender distribution was heavily skewed toward females (15 out of 17), accounting for approximately 88% of the sample, which may have influenced observed differences in stress perception and cognitive function, thereby limiting the generalizability of findings. Although the MMSE is a well-validated cognitive screening tool, it is primarily designed for older populations and may lack sensitivity in detecting subtle cognitive variations among young adults. While criterion validity studies show that age and education impact MMSE scores, construct validity appears unaffected by educational level.[8] However, highly educated individuals particularly in early stages of dementia, may experience a ceiling effect, reducing the tool's sensitivity in detecting mild cognitive impairment (MCI).[16] Similarly, the PSS-10, being a self-report instrument, is vulnerable to recall bias and may not fully capture objective stress levels, particularly in structured academic environments. It is also important to consider that stress perception may differ significantly between younger and older adults.[9] Additionally, the absence of blinding in test administration introduces potential observer bias, which could have affected responses or scoring. While statistical significance was not achieved in some comparisons, Cohen's d analysis offered meaningful insights. A large effect size for cognitive scores (d = 0.95) suggests a notable difference between fast and slow learners, indicating cognitive function may influence academic performance despite the small sample. In contrast, the small effect size for stress (d = 0.29) indicates a weaker link with learning pace, supporting cautious interpretation of stress-related findings. Finally, the cross-sectional design limits causal inference, and all associations should be interpreted with caution. Nevertheless, the study minimized other sources of bias through standardized tools, consistent administration protocols, and supervised data collection to ensure procedural fidelity.

Strengths of the Study

A major strength of this study is that the interdisciplinary approach enabled a culturally contextualized assessment, providing richer insights and improving internal validity than standard tools alone. The use of purposive sampling based on objective academic performance further strengthened the study's methodological rigor by ensuring meaningful learner categorization.

Generalizability

Due to the small, homogeneous sample and single-centered design, generalizability is limited, as variables like cultural background, curriculum, and stress management could influence the outcomes in different cohorts.

Implications for Practice or Policy

Emerging advances in simultaneous EEG and MRI techniques including structural MRI, Diffusion Weighted Imaging (DWI), Diffusion Tensor Imaging (DTI), functional MRI (fMRI), and MR Connectome offer powerful tools to explore the dynamic interplay between cognitive processes, brain networks, and academic performance. These modalities allow real-time visualization of how the brain processes, stores, and retrieves information, offering critical insights for enhancing learning outcomes. A wide range of validated cognitive assessment tools are available for such use, including digital platforms such as Wechsler Adult Intelligence Scale-IV (WAIS-IV), Wechsler Memory Scale-IV (WMS-IV), and Raven's Progressive Matrices (RPM), NeuroTrax, Mindstreams, Cognitive Drug Research (CDR) System, CANTAB (Cambridge Neuropsychological Test Automated Battery), Cogstate, Automated Neuropsychological Assessment Metrics (ANAM), Central Nervous System Vital Signs (CNSVS), NIH Toolbox Cognitive Battery, Cognitron, Vienna Test System, Montreal Cognitive Assessment (MoCA), Digital Clock Drawing Test (dCDT), Wisconsin Card Sorting Test (WCST), Trail Making Test (TMT), Stroop Test, Verbal Fluency Test, and Digit Span, Rey Auditory Verbal Learning Test (RAVLT). Their cross-cultural adaptability, digital integration, and clinical reliability position them as gold standards for academic and research settings.[17]

Future Research Directions

To enhance the robustness of these findings, future studies should include more demographically diverse samples. Longitudinal studies can provide valuable insights into how cognitive function and stress levels influence learning trajectories. Further refinement of cognitive assessment tools for young adults, possibly incorporating both standard and culturally rooted components, would improve sensitivity and relevance. The development and validation of Ayurveda cognitive assessment frameworks may also help establish a standardized approach for integrating traditional epistemologies into educational psychology research.

CONCLUSION

The findings of the present study suggest that cognitive abilities are more closely associated with students' learning pace than with their perceived stress levels. While stress is often considered a determinant of academic performance, our results indicate that variations in cognitive performance are better explained by whether a learner belongs to a fast or slow learning group. This highlights that intrinsic cognitive capacity plays a greater role in shaping learning outcomes compared to short-term perceived stress. Therefore, interventions aiming to improve academic performance should prioritize strengthening cognitive skills and adopting individualized teaching strategies according to the learner's pace, rather than focusing solely on stress management. Future longitudinal studies are required to validate these findings and further clarify the interplay between cognition, stress, and learning pace over time.

REFERENCES

1. Martínez Pérez JF, Bertone MS.Cognitive neuroscience and how students learn: Hype or hope. Int J Psychol Res. 2019;12(1):6–8. doi:10.21500/20112084.4047.
2. Goldberg H. Growing brains, nurturing minds—Neuroscience as an educational tool to support students' development as life-long learners. Brain Sci. 2022;12:1622. doi:10.3390/brainsci12121622.
3. Dwivedi L, Dwivedi BK, Goswami PK, editors. Caraka Samhita of Maharshi Agnivesha with Ayurvedadipika Sanskrit commentary by Chakrapanidatta, Tattvaprakashini Hindi commentary, and selective commentary from Jalpakalpataru by Gangadhar. Part II (Nidana, Vimana, Sharira and Indriya Sthana); Sharira Sthana, Chapter 1, Verses 20–21. 1st ed. Varanasi: Chaukhamba Krishnadas Academy; 2006. p. 958.
4. Gupte GJ. Cognitive Dynamics of "Antaḥkaraṇa Pañcaka." J Indian Med Herit. 2024;3:170–177. doi:10.4103/jimh.jimh_58_24
5. Chaudhary S, Goel S, Srikanth N, Ahmad A. Ayurveda based dietary and lifestyle advocacy for mental health and psychiatric disorders. New Delhi: Central Council for Research in Ayurveda Sciences, Ministry of AYUSH,

Government of India; 2019. Available from: https://ccras.nic.in/wp-content/uploads/2024/07/Ayurveda-Based_Dietary_Guidelines_Mental_Disorders-1.pdf
6. Dwivedi L, Dwivedi BK, Goswami PK, editors. Caraka Samhita of Maharshi Agnivesha with Ayurvedadipika Sanskrit commentary by Chakrapanidatta, Tattvaprakashini Hindi commentary, and selective commentary from Jalpakalpataru by Gangadhar. Part II (Nidana, Vimana, Sharira and Indriya Sthana); Nidana Sthana, Chapter 7, Verse 5. 1st ed. Varanasi: Chaukhamba Krishnadas Academy; 2006. p. 736.
7. Mamidi P, Gupta K. Obsessive compulsive disorder – 'Sangama Graha': an Ayurveda view. J Pharm Sci Innov. 2015;4:156–64. doi:10.7897/2277-4572.04335
8. Kochhann R, Cerveira MO, Godinho C, Camozzato A, Chaves MLF. Evaluation of Mini Mental State Examination scores according to different age and education strata, and sex, in a large Brazilian healthy sample. Dement Neuropsychol. 2009;3:88–93. doi:10.1590/S1980-57642009DN30200004
9. Jiang JM, Seng EK, Zimmerman ME, Sliwinski M, Kim M, Lipton RB. Evaluation of the reliability, validity, and predictive validity of the subscales of the Perceived Stress Scale in older adults. J Alzheimers Dis. 2017;59:987–996. doi:10.3233/JAD-170289
10. Rimmele U, Ballhausen N, Ihle A, Kliegel M. In older adults, perceived stress and self-efficacy are associated with verbal fluency, reasoning, and prospective memory (moderated by socioeconomic position). Brain Sci. 2022;12:244. doi:10.3390/brainsci12020244
11. Guidelines and Protocols Advisory Committee. Cognitive Impairment – Recognition, Diagnosis and Management in Primary Care: Standardized Mini-Mental State Examination (SMMSE). Victoria (BC): British Columbia Ministry of Health; 2014. Available from: https://www2.gov.bc.ca/assets/gov/health/practitionerpro/bcguidelines/cogimpair.pdf
12. Vertesi A, Lever JA, Molloy DW, Sanderson B, Tuttle I, Pokoradi L, et al. Standardized Mini-Mental State Examination. Use and interpretation. Can Fam Physician. 2001 Oct;47:2018–23. PMID: 11723596; PMCID: PMC2018449.
13. Hossain M. A study on perceived stress among young adults during social isolation. Int J Indian Psychol. 2020;8(2):331–9. doi:10.25215/0802.040.
14. Dwivedi D, Kaur N, Shukla S, Gandhi A, Tripathi S. Perception of stress among medical undergraduate during coronavirus disease-19 pandemic on exposure to online teaching. Natl J Physiol Pharm Pharmacol 2020;10(08):657-662.
15. Anbumalar C, Dorathy AP, Jaswanti VP, Priya D, Reniangelin D. Gender differences in perceived stress levels and coping strategies among college students. Int J Indian Psychol. 2017;4(4). doi:10.25215/0404.103.
16. Mitchell AJ. The Mini Mental State Examination (MMSE): an update on its diagnostic validity for cognitive disorders. In: Larner AJ, editor. Cognitive Screening Instruments. London: Springer London; 2013. p.15–46. doi:10.1007/978-1-4471-2452-8_2
17. Vitacca M. New horizons in neuropsychological assessment: A systematic review on the availability of digital tools for the assessment of attentive abilities and executive functions in adults [master's thesis]. Padova, Italy: University of Padova, Department of General Psychology; 2024. Available from: https://thesis.unipd.it/handle/20.500.12608/75334

Cite this article as:

Pavneet Kaur and Nithin Krishnan R. Exploring the relationship between Neuropsychological biomarkers and learning pace: A comparative study of slow and fast learners Integrating Ayurveda Cognitive Domains. Int. J. Res. Ayurveda Pharm. 2025;16(5):72-79 DOI: http://dx.doi.org/10.7897/2277-4343.165173

Source of support: Nil, Conflict of interest: None Declared