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When the Mind Fails to Rest: Sleep Quality and Stress Effects on Cognitive Process

Rupa Bhatt
Military Hospital, Dehradun

Rohit Chauhan
Panjab University, Chandigarh

The two factors, sleep and stress, are some of the most impactful and yet neglected aspects which define the young adult mindset in thinking, learning, and performing in real life. The current research investigated the impacts of the quality of sleep and levels of stress on cognitive performance of the young adults. A sample of 80 participants aged 18–30 years completed standardized measures of sleep quality, perceived stress, and cognitive performance. Two-way ANOVA indicated a significant main effect of the quality of sleep, $p < .01$, poor sleepers reported more cognitive failures than good sleepers. There was also no significant stress level, $p > .05$ and sleep-stress interaction was non-significant, $p > .05$. Correlation tests found that sleep quality had significant associations with cognitive performance ($r = .494$, $p < .001$), stress level had significant associations with cognitive performance ($r = .368$, $p < .01$) and sleep quality had significant associations with stress level ($r = .277$, $p < .05$). Multiple regression revealed that sleep quality and stress covariated the cognitive performance significantly, $p < .001$, and explained the variance of 30.2% ($R^2 = .302$). The sleep quality (*â*=.425, $p < .001$) and stress level (*â*=.250, $p < .05$) also were significant predictors. These results point out sleep quality as a strong predictor of cognitive functioning, with the implication that the role of stress plays a smaller but significant role at the predictive level. The implications on academic well-being, sleeping hygiene and stress management are addressed.

Keywords: Cognitive performance, Sleep quality, Sleep deprivation, Stress, Young adults

Sleep is a natural, essential biological process and is the basis of cognitive, emotional, and physiological health. It can be restorative to the brain and the body and allows consolidation of new information, affect control, and homeostasis (Walker, 2017). Cognitive functions including attention, memory consolidation, and executive functions, require some sleep, in particular, restorative sleep. As an example, the model developed by Susanne Diekelmann and Jan Born (2010) states that slow-wave sleep (SWS) and rapid eye movement (REM) sleep fulfil different though complementary functions in memory consolidation: SWS facilitates hippocampo-neocortical transfer, whereas REM may contribute to the memory consolidation and integration process through its synaptic function. Empirical research indicates that insufficient or poor quality sleep has been linked to lapses in attention, memory encoding and retrieval, slower response time and greater impairment in decision making (Lim and Dinges, 2010; Killgore, 2010).

On the other hand, stress has a strong effect on cognitive performance. The most famous law, the Yerkes–Dodson Law (1908), assumes an inverted U-shaped association between arousal (stress) and performance: moderate arousal by the stress can increase the alertness and cognitive functioning, but excessive levels of stress or a chronic one are detrimental to performance. Stress triggers the hypothalamic-pituitary-adrenal (HPA) axis activations that increase cortisol concentration, which at prolonged high doses can damage the hippocampal functioning, attentional control, and memory consolidation (Lupien et al., 2009; McEwen, 2012). In particular, chronic exposure to corticosterone /cortisol is associated with the dendritic shrinkage of the hippocampal neurons, the neurogenesis, and, consequently, the impaired cognitive functioning.

Notably, sleep and stress are interconnected in a reciprocal relationship. High stress may disrupt the circadian rhythms regulation, sleep latency, sleep fragmentation, and slow-wave and REM sleep. On the other hand, poor or faulty sleep changes physiological and emotional control, increases baseline cortisol, decreases stress recovery and increases susceptibility to stressors (Kim & Dimsdale, 2007; Meerlo et al., 2008). Neurobiologically, chronic stress can change sleep architecture through changes in SWS and REM sleep and in the process, compromising the very same sleep processes that facilitate learning and memory (Diekelmann and Born, 2010).

The young adult population, especially university students is a special population of interest: they are often exposed to poor sleep patterns, academic stress, social and work stress, lifestyle habits (e.g., caffeine use, screen time, night studying) that negatively affect the quality of their sleep and are also facing high levels of psychological stress at the same time. It has been demonstrated that this group is especially susceptible to inability to sleep and increased stress and that when destabilized this way, their cognitive abilities that play a vital role in academic performance are affected: attention, problem solving, planning and executive control (Lund et al., 2010; Buysse et al., 1989).

Although, there are strong sources of evidence on separate impact of sleep quality and stress on cognitive functioning, there are few studies on the combined effect of sleep quality and stress level- i.e. how sleep quality and stress level can interact to influence cognitive functioning in normal (non-clinical) populations. Sleep and stress can be synergistic (or multiplicative) when taken together: stress can worsen the cognitive impairment of poor sleep, or high stress can worsen the quality of sleep even more and hence increase cognitive impairment. This interaction is especially important to understand within the context of young adult groups with academic and work performance potentially being highly vulnerable to the effects of this cognitive inefficiency.

Hence, the current study aims at filling this gap by examining the independent and interactive influences of sleep quality and stress level on cognitive performance in a population of young adults. In this way, the study seek to understand whether sleep quality can counteract the adverse impact of stress on the functioning of the human brain, and whether the interaction of sleep deficiency and high stress is a specific risk factor of compromised cognition.

Objectives

1. To examine the effect of sleep quality on cognitive performance.
2. To examine the effect of stress level on cognitive performance.
3. To study the interaction effect of sleep quality and stress level on cognitive performance.

Hypotheses

H1: Sleep quality will significantly effect cognitive performance.

H2: Stress level will significantly effect cognitive performance.

H3: There will be a significant interaction effect between sleep quality and stress level on cognitive performance.

H4: There is a positive correlation between Sleep Quality and Stress Levels.

H5: There is a positive correlation between Sleep Quality and Cognitive Performance.

H6: There is a positive correlation between Cognitive Performance and Stress Levels.

H7: Sleep Quality and Stress Levels will significantly predict Cognitive Performance.

Method

Research Design

The study employed a quantitative, correlational research design to examine the effects of sleep quality and stress levels on cognitive performance among young adults. A between-subjects factorial design (3 × 2) was used for the ANOVA, with stress level (low, moderate, high) and sleep quality (good, poor) as independent variables, and cognitive performance as the dependent variable. In addition, correlational and regression analyses were conducted to explore the associations and predictive power of sleep quality and stress levels on cognitive performance.

Sample

The study included a total of 85 participants between the ages of 18 and 28 years, recruited through random sampling from various universities across North India. All individuals in the sample were unmarried. Prior to participation, each prospective subject was screened, and those with any self-reported or previously diagnosed psychiatric or neurological conditions were excluded to maintain the psychological and clinical integrity of the sample.

The final sample consisted of both 79 male and female participants from diverse academic backgrounds. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection.

Tools used:

1. *Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989)* – Assesses sleep quality over the past month across seven components. Higher scores indicate poorer sleep. Psychometrically, the PSQI demonstrates good internal consistency, with reported Cronbach's alpha values typically ranging from 0.70 to 0.83, and strong test–retest reliability over short intervals. Its construct validity is well established through significant correlations with objective sleep measures and clinical diagnoses, making it a widely accepted tool in sleep research.

2. *Perceived Stress Scale (PSS; Cohen et al., 1983)* – Measures perceived stress in daily life. Higher scores reflect greater stress. The scale shows strong reliability, with Cronbach's alpha values generally between 0.78 and 0.91 across different populations. It also demonstrates excellent construct and criterion validity, evidenced by consistent associations with psychological outcomes such as anxiety, depression, and physiological markers of stress, including cortisol levels.

3. *Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982)* – Evaluates lapses in perception, memory, and motor function as indicators of cognitive performance. The CFQ has shown high internal consistency, with Cronbach's alpha values typically around 0.80 to 0.90, and satisfactory test–retest reliability. Its validity is supported through correlations with attentional deficits, workload, and measures of executive functioning, confirming its utility as a measure of everyday cognitive performance.

Procedure

After obtaining informed consent, participants completed the PSQI, PSS, and CFQ questionnaires anonymously. Responses were scored as per the standardized scoring manuals. Participants were categorized as good or poor sleepers based on PSQI cut-offs and as low, moderate, or high stress groups according to PSS scores.

Statistical Analysis

Data were analyzed using IBM SPSS (Version 21). Descriptive statistics were computed, and a two-way ANOVA was conducted to test the main and interaction effects of sleep quality and stress level on cognitive performance. Pearson's correlation analysis was conducted to assess the relationships among sleep quality, stress level, and cognitive performance. Multiple regression analysis was used to determine whether sleep quality and stress level significantly predicted cognitive performance. Statistical significance was set at $p < .05$.

Results

Descriptive statistics from table 1 showed that poor sleepers had higher mean CFQ scores (M = 49.12, SD = 8.35) than good sleepers (M = 41.06, SD = 6.27), indicating more frequent cognitive lapses.

Table 1: Descriptive Statistics for Cognitive Performance by Stress Level and Sleep Quality (N = 79)

Stress Level	Sleep Quality	M	SD	n
Low	Poor	39.00	17.79	4
	Good	34.88	10.01	8
Moderate	Poor	48.04	16.31	24
	Good	36.52	13.55	27
High	Poor	57.75	19.91	12
	Good	41.50	7.59	4

Figure 1: Comparison showing how Cognitive Performance varies across different Stress Levels and Sleep Quality conditions

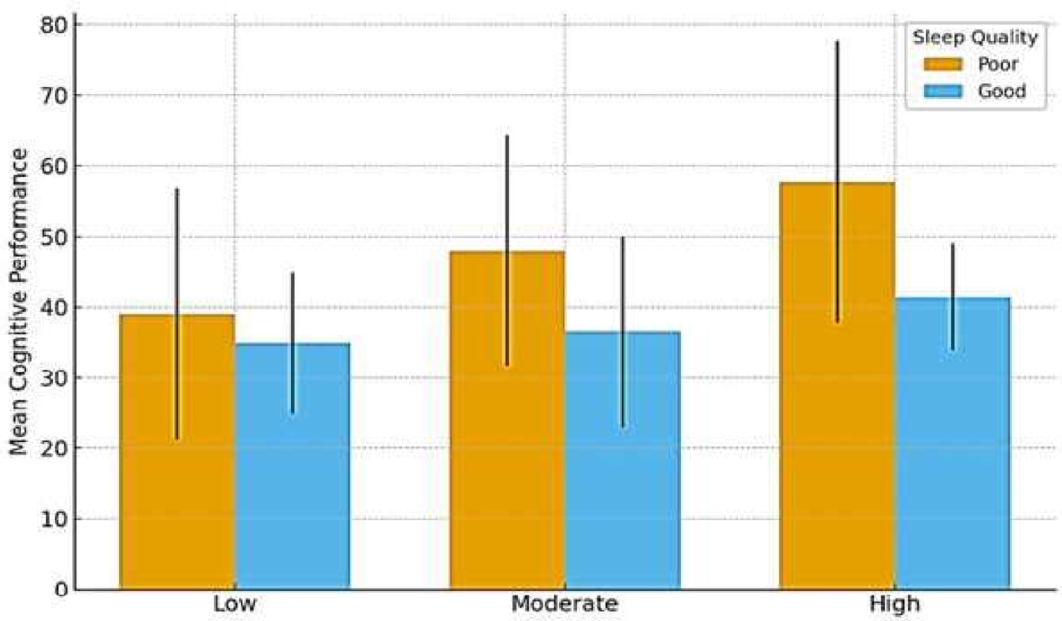

Table 2: Two-Way ANOVA Summary Table for the Effects of Sleep Quality and Stress Level on Cognitive Performance

H1: Sleep quality will significantly effect cognitive performance.

Source	df	F	Sig.
Stress Level	2	2.58	.083
Sleep Quality	1	9.89	.002*
Stress Level × Sleep Quality	2	0.45	.638

$p < .05$

The two-way ANOVA from table 2 revealed a significant main effect of sleep quality on cognitive performance, $F(1,73) = 9.89$, $p>.01$, indicating that participants with poor sleep quality demonstrated more cognitive failures than those with good sleep quality. Additionally, sleep quality showed a strong positive correlation with cognitive performance ($r = .494$, $p < .001$) and emerged as a significant predictor in the regression model ($\beta = .425$, $p < .001$).

Thus, H1 was strongly supported.

H2: Stress level will significantly effect cognitive performance.

The main effect of stress level on cognitive performance was not significant in the ANOVA from table 2, $F(2, 73) = 2.58$, $p > .05$, indicating no categorical group differences across low, moderate, and high stress levels.

However, stress level demonstrated a significant positive correlation with cognitive performance ($r = .368$, $p < .01$) and was a significant predictor in the regression model ($\beta = .250$, $p < .05$).

Thus, H2 was partially supported. Stress level did not show a significant group effect, but as a continuous variable, it significantly predicted cognitive failures.

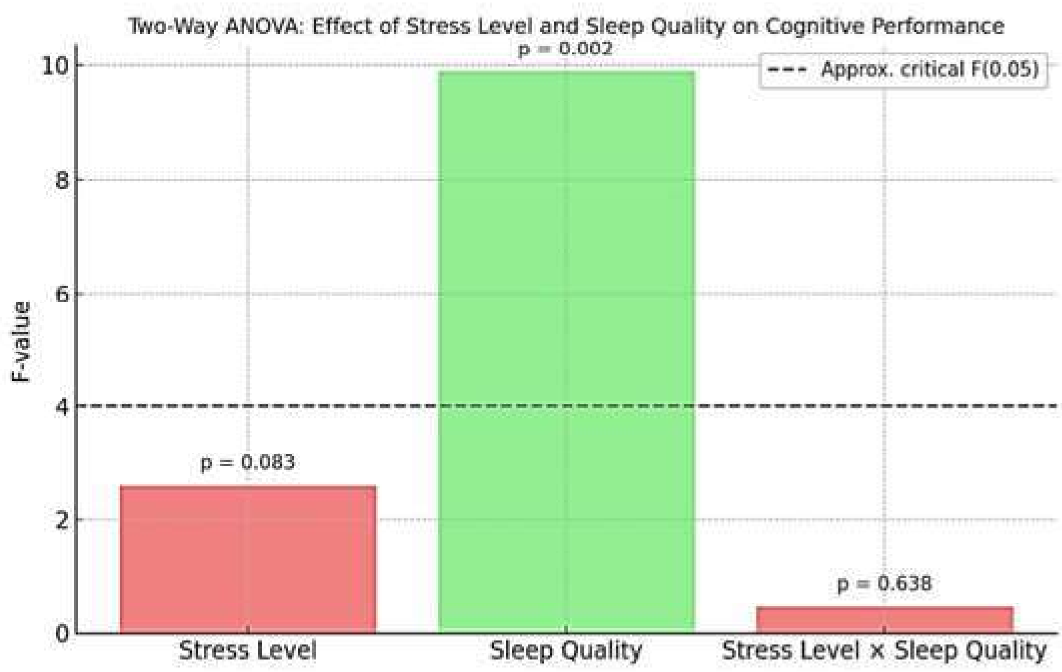

Figure 2: Summary of your ANOVA results

H3: There will be a significant interaction effect between sleep quality and stress level on cognitive performance.

Table 3: Post Hoc Comparisons for Stress Levels (Bonferroni Adjustment)

Stress Level	Stress Level	Mean Difference	SE	p
Low	Moderate	-5.69	4.91	.750
Low	High	-17.44	5.84	.012*
Moderate	High	-11.75	4.38	.027*

p < .05

Analysis of interaction effects from table 3 showed that sleep quality and stress level did not significantly interact in predicting cognitive performance, $F(2, 73) = 0.45$, $p > .05$. This indicates that the influence of sleep quality on cognition remained consistent across different stress levels.

Therefore, H3 was not supported.

Table4: Correlation between Sleep Quality, Stress Levels and Cognitive Performance

Variables	Sleep Quality	Stress Levels	Cognitive Performance
Sleep Quality	1	.013*	.000**
Stress Levels	.013*	1	.001**
Cognitive Performance	.00088	.001**	1

*correlation is significant at the 0.05 level

**correlation is significant at the 0.01 level

H4: There is a positive correlation between sleep quality and stress levels.

The correlation analysis from table 4 revealed a small but significant positive relationship between sleep quality and stress level, $r = .277$, $p<.005$, indicating that poorer sleep quality was associated with higher stress levels, supporting H4.

H5: There is a positive correlation between sleep quality and cognitive performance.

A significant and moderately strong positive correlation from table 4 was found between sleep quality and cognitive performance, $r = .494$, $p < .001$, showing that poorer sleep quality was associated with more frequent cognitive failures, supporting H5.

H6: There is a positive correlation between cognitive performance and stress levels.

Stress level was significantly and positively correlated (from table 4) with cognitive performance, $r = .368$, $p < .01$, demonstrating that higher stress was related to greater cognitive failures, thus, supporting H6.

H7: Sleep Quality and Stress Levels will significantly predict Cognitive Performance.

Table 5: Possible predictors of cognitive performance.

Hypothesis	Regression Weights	R^2	F	p-value	Hypothesis Rejected
H7	Sleep Quality+ Stress Levels → Cognitive Performance	.302	16.684	.000	Failed to reject hypothesis

Multiple regression analysis from table 5 showed that the combined model of sleep quality and stress levels significantly predicted cognitive performance, $F(2, 77) = 16.68$, $p < .001$, explaining 30.2% of the variance ($R^2 = .302$).

Both predictors made significant contributions:

- Sleep quality ($\beta = .425$, $p < .001$)
- Stress level ($\beta = .250$, $p < .05$)

These findings confirm that both variables significantly impact cognitive performance, supporting H7.

Discussion

The present study set out to investigate the effect of sleep quality and stress levels on the cognitive performance in young adults, by means of ANOVA, correlation analysis, and multiple regression analysis. The results were partial confirmation of the original hypotheses. Though, sleep quality appeared to be a consistent and meaningful predictor of cognitive performance across analyses, the influence of stress was weaker and largely non-significant, and the interaction between sleep and stress failed to be significant.

Effects of Sleep Quality on Cognitive Performance

The one-way ANOVA showed the existence of significant mean differences in cognitive performance when levels of sleep quality are observed, where higher sleep quality was reported to have better performance by the participants with higher quality of sleep. The observation was further supported through correlation analysis which revealed that there was a positive relationship between sleep quality and cognitive performance. In line with these findings the regression analysis showed that even after accounting stress levels, sleep quality was a strong predictor of cognitive performance.

These are consistent with the literature available that shows that proper sleep improves the attentional processes, working memory and executive functioning (Killgore, 2010; Lim and Dinges, 2010). Sleep promotes neurocognitive recovery and underpins the functioning of the prefrontal cortex which is critical towards higher-order reasoning. Similar to the current finding that better sleep leads to high cognitive performance, the pre-existing sleep -dependent memory consolidation theory (Diekelmann and Born, 2010) also supports the current finding.

Effects of Stress Levels on Cognitive Performance

The results of ANOVA did not indicate significant differences in the cognitive performance of the low, moderate and high stress groups. The correlational analyses also showed that there was a weak non-significant relationship between stress and cognition. The regression model also showed that the level of stress did not significantly predict the level of cognitive performance in the presence of the sleep quality as a covariate.

These results can be explained by references to the Yerkes -Dodson principle (1908) according to which the middle levels of stress do not negatively affect performance but, on the contrary, can help in alertness. Since most of the participants stated that they were moderately stressed, there was no likelihood that cognitive functioning could have been compromised. Also, personal variations in emotional management and coping abilities can act as stress-related cognitive impairment buffers (Compas et al., 2017). The noticed minor negative effects, in their turn, might be indicative of possible cognitive disruptions on an increased level of stress, which might be mediated by such mechanisms as cortisol-related disruption of hippocampal (McEwen, 2012).

Interaction Effect of Sleep and Stress

The two-way analysis of variance, showed that there was no significant interaction between stress level and sleep quality meaning that the effect on the synergistic or multiplicative effect of the two variables on the cognitive performance was not significant. This finding implies that in non-clinical population, sleep and stress are independent psychological variables to a considerable degree.

However, the lack of interaction between sleep and stress may be explained by the fact that in the present study, there was a relatively good consistency in terms of sleep patterns and moderate stress levels among young adults, and thus lacked variability to generate a conjunctive effect (Kim and Dimsdale, 2007). Also a possibility exists that the determining element was with more strength on the quality of sleep, thus hiding the effect of stress.

Theoretical Implications

The findings support the assumptions of the Cognitive Activation Theory of Stress (Ursin and Eriksen 2004), which highlight the critical role of the recovery processes, especially high-quality sleep, in maintaining cognitive efficiency in the face of stress. Furthermore, the current study proceeds this theoretical framework by showing that sleep is not only a restorative process, it is also a powerful and autonomous factor of cognitive performance.

The non-significance of the interaction effect is another indication that even in non-clinical populations, a person's cognitive functioning is dependent on the restorative mechanisms like sleep rather than fluctuations of stress.

Practical Implications

The study emphasizes the significance of promoting healthy sleeping patterns along with stress-management intervention in young adults. It is recommended that in academic institutions, counseling centers, and mental-health practitioners include the following components:

- Sleep hygiene workshops
- Interventions based on cognitive-behavioral therapy of insomnia (CBT-I)
- Psychoeducational interventions on the interaction between stress and the sleep.
- Circadian regulation Lifestyle changes.

These programs can be used to enhance attention, memory, decision making, and academic performance among student populations.

Limitations and Future Directions

There are a number of limitations that should be noted. To begin with, the design used is cross-section, meaning that it does not provide a causal interpretation. Second, self-reported sleep and stress raise the chances of bias and subjectivity. Third, the sample was only made up of young adults and this also did not allow generalization.

The future research ought to include:

- Objection testing of sleep, including actigraphy or polysomnography.
- Physiologic indicators of stress, such as cortisol tests.
- Longitudinal or experimental research designs.
- Further heterogeneous cohorts of participants.

The investigation of moderating variables (e.g., emotion regulation, resilience, or chronotype) can perhaps help clarify more complicated pathways between sleep, stress, and cognition, as well.

Conclusion

Across all the analyses that have been conducted through ANOVA, correlation, and regression the findings are consistent in showing that sleep quality itself is a valuable and important predictor of cognitive performance in young adults. Those who claimed to have better sleep quality scored significantly better in the administered cognitive tests, thus illustrating the importance of a good sleep in maintaining focus, recall and intelligence. Although the magnitude of stress was also a factor to consider as a covariate, the factor predicted cognitive outcomes not significantly and neither interacted with sleep quality. Therefore, the quality of sleep proves to be a stronger predictor of cognitive functioning in non-clinical populations of young adults than stressors in everyday life.

Combined, this evidence shows that optimum sleep is not just a lifestyle choice factor but a key determinant factor in the cognitive efficiency and mental health. Since young adulthood can be defined by increased academic and emotional pressure, the development of strict sleep hygiene measures, as well as productive coping strategies to stress proves to be the factor that may foster significant improvements in cognitive functioning, output, as well as, overall functioning. Schools and mental-health practitioners can facilitate individuals to perform at their highest mental potential by creating awareness to combat sleep and stress problems and applying evidence-based interventions to help young adults build long-term psychological resilience.

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Rupa Bhatt, Trainee Psychologist, Military Hospital, Dehradun

Rohit Chauhan, Senior Research Fellow, Panjab University, Chandigarh