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Research Paper

Unveiling the Relationship of Mental Load and Academic Performance: An Analysis of Prose Memory Tasks

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ABSTRACT

Different tasks clearly require various levels of mental effort, with success or failure determined by how hard we effort. Difficulties can stimulate us to work harder in some circumstances. However, the broad consensus that stress, exhaustion, and mental load all have a major impact on the quality of human performance. In this sense, the current study seeks to investigate the relationship between mental effort and performance among postgraduate students, as well as to uncover its relationship with reverent demographics. The auditory verbal prose recall task was performed and the result found that as the complexity of mental load increase's the performance of participants diminishes.

Keywords: *Mental Effort, Performance, Post-graduate, Students*

It is widely acknowledged that mental load, stress, and exhaustion have an immense effect on human performance (Hancock & Desmond, 2001). Mental effort is one of the most common and intuitive aspects of mental life. Different tasks clearly necessitate varying levels of cognitive effort, with success or failure determined by how hard we work. Difficulties can motivate us to work harder in some circumstances. In others, we disengage because we believe the required effort is not worthwhile, or because we are exhausted or fatigued (Westbrook & Braver, 2015).

Initially, the concept of mental effort was employed to assess an individual's level of effort in actively processing information that was provided. Perceived demand characteristics, perceived self-efficacy, and the degree and depth of information processing were considered to be combined factors that impact each other and ultimately decide the mental effort performed. Kevin et. al (2016) studied neuronal and psychophysiological correlates of human performance under stress and high mental effort. 14 and 20 healthy volunteers participated in two experiments. Study 1 used pupillometry and study 2 used fNIRS. Higher task complexity decreased performance, increased tonic pupil diameter, heart rate, and lateral prefrontal cortex activity, and decreased phasic pupil response and heart rate variability. Mental strain and tension cost psycho-physiologically. Stress may motivate and engage cognitive resources to reduce its negative effects on task performance. Similarly, Unal, Lindasteg, & Kaiepstude (2012) examined the effects of music on mental effort and

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driving performance. 69 people drove a driving stimulator with or without music. The researchers find that music while driving increases mental effort and lowers performance.

Researches revealed that during operational performance, prefrontal cortex plays a significant role and having the capacity to monitor performance quality and progress toward task goals. The posterior medial frontal cortex (pMFC) is the core node in a larger network dedicated to performance monitoring, action selection, and adaptive behaviour (Ullsperger et al., 2014; Ninomiya et al., 2018). Further, the pMFC is sensitive to error and failure to fulfil a task goal (Ullsperger et al., 2007); failure detection is an essential cue for compensating techniques, such as greater mental effort investment (Hockey, 1997). In addition, task performance and a perception of effort were found to be two behavioural manifestations of mental workload in the notion of mental workload. It is discovered that due to limits in our ability to self-monitor, subjective effort assessments have been demonstrated to deviate from performance measures. Similarly, performance cannot be seen as a simple indicator of workload. Task demands and effort have a complicated and consequently unpredictable relationship, which is why Vidulich & Wickens (1986) caution researchers against interpreting performance and subjective effort assessments hastily. For instance, participants' performance scores often decline when task demands increase, although it is conceivable in many situations that participants would exert more effort to maintain and possibly improve task performance. As a result, when a researcher notices a rise in task performance scores, further measurements are required to determine if the subject is finding the task simpler (i.e., some type of learning has happened; anxiety has lessened) or working harder.

Thus, the *present study* starts with the observation that people experience mentally challenging tasks differently. Some enjoy cognitively challenging tasks, while others can't wait to finish them. Individual differences are evident in both "in the moment" and "generalised thoughts and feelings" about mental effort (Paas, 1992; Robinson and Morsella, 2014). (e.g., I often find math questions require a lot of effort; see for example, Dornic et al., 1991; Cacioppo et al., 1996). This difference between momentary effort and generalised ideas and feelings is similar to the state-trait distinction. Therefore, in this way, we focused on measuring the “in the moment” experience of effort during a cognitively demanding task.

Objectives

- To examine the relationship between mental effort and performance among post graduate students.
- To study the difference in mental effort by gender, language, handedness, faculty, locality and schooling among post graduate students.
- To study the difference of performance through low and high levels mental effort among post graduate students.

Hypothesis

- H_1: There will be the difference in mental effort by gender, language, handedness, faculty, locality and schooling among the post graduate students.
- H_2: There will be negative relationship between mental effort and performance among post graduate students.
- H_3: There will be difference in performance by levels (low & high) of mental effort among post graduate students.

METHOD

Participants

The present study sampled 100 postgraduate students from Aligarh Muslim University, Aligarh, with ages ranging from 20 to 25 and a mean age of 22.50. The sample was gender-balanced and voluntary participation.

Tools

- **Personal Data Sheet:** The personal data sheet let researchers collect participant demographics. The sheet includes age, gender, language, handedness, faculty, schooling type, and locality.
- **Prose Memory Task:** The auditory verbal prose recall task recalling a short story was employed in this study. After remembering the story, subjects were asked nine questions regarding it. Scoring questions measures the performance. Correct responses determine the Immediate Prose Recall score. Recall time (ms) also measured working memory.

Performance

The study predicted that paragraph understanding and the comprehension will affect recognition performance. Thus, it was hypothesised that participants who were bound to view paragraph questions by a certain context would choose more answers on multiple-choice questions that were compatible with this meaning than the other. Answers were scored to assess performance. The Immediate Prose Recall score is the number of right responses with true/false and milliseconds.

Procedure

The participants were tested individually, and each participant was told that they would hear a story and then be asked to recall the story to the experimenter. The material was then read aloud to each individual at a rate of one word per second. Following that, the participants were instructed to tell the experimenter what they remembered about the story. The reconstruction of the story by each participant was immediately recorded. As a result, synonyms and tense shifts were permitted. An oral recognition test was performed immediately after each participant's reconstruction of the story. The test consisted of ten questions based on the same story. The questions were presented in a random order, ranging from easy to difficult and the participant must respond appropriately. Following that, the participants were thanked for their participation in the study.

Statistical tools

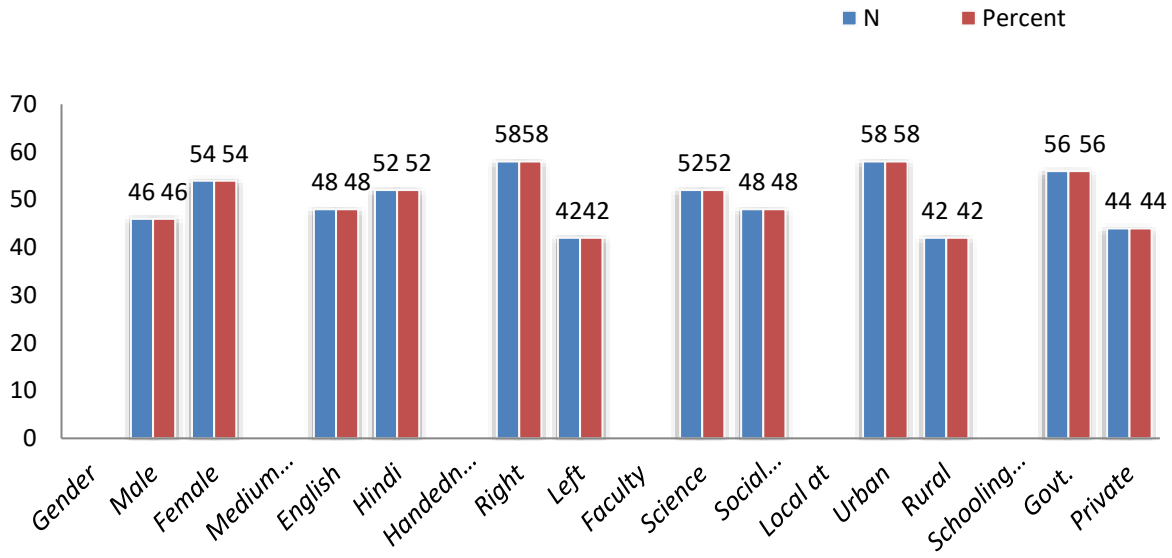
Descriptive statistics like mean and standard deviation were estimated to understand variable distribution. Also, for the mean difference between groups was determined using independent samples t-test and finally Pearson product moment correlation were established to determine the linear association between mental effort and performance. The analysis was done with SPSS 27.

Result

In this section, the results obtained from the statistical analyses have been recorded and discussed. The descriptive statistics, such as mean and standard deviation was calculated for variables under study. Independent samples t-test was used to find out the mean difference for mental effort and performance based on demographic variables. Pearson Product

Moment Correlation was estimated to examine the linear correlation between mental effort and performance.

Figure 3.1 Graphical Representation of Demographic Details of the Participants



In social science research, the respondents' demographic characteristics often play a significant role in how they express and respond to a problem. With this in mind, the demographic data for all 100 subjects, including gender, language, handedness, faculty, locality and Schooling have been examined and are shown in figure 3.1. According to the figure 3.1, 54% of the 100 survey respondents were female and 46% were male. Related to the language, 82% of respondents spoke English and 18% spoke Hindi. Likewise, 84% of respondents in the current survey were right handers and 16% were left handers. Furthermore, the data revealed that 62% of the students were science academics and 38% were social science faculty students. Similarly, 68% of respondents in the current survey were urban and 32% were rural. And finally, 56% of participants attended public schools and 44% attended private schools. Descriptive statistics for prose memory task was calculated based on demographic characteristics of participants and are presented in tabular form in following paragraphs.

Table 3.2 Mean Difference and Independent Sample t-Test on Prose Memory Task Among Gender, Language, Handedness, Faculty, Locality and Schooling.

Variable	M	N	SD	*t* (98)	*p*	Cohan's *d*
Gender						
Female	17.03	46	6.14	2.87	.021	0.42
Male	19.85	54	7.43			
Total	18.44	100	6.89			
Language						
Hindi	18.49	48	5.69	3.83	.014	0.51
English	21.09	52	4.62			
Total	19.78	100	5.16			
Handedness						
Right	23.46	58	4.76	3.45	.001	0.79
Left	18.68	42	2.31			

Variable		M	N	SD	*t* (98)	*p*	Cohan's *d*
	Total	21.07	100	3.53			
Faculty							
	Science	22.45	52	3.41	4.32	.032	0.74
	Social Science	17.66	48	5.43			
	Total	20.05	100	4.42			
Local at							
	Urban	21.07	58	6.19	3.04	.022	0.64
	Rural	16.87	42	4.33			
	Total	18.97	100	5.26			
Schooling at							
	Private	22.9	56	3.35	3.81	.014	0.72
	Govt.	18.07	44	3.28			
	Total	20.49		100	3.31		

Table 3.2, shows that performance while performing Prose Memory Task in female participants was high statistic (17.03± 6.14) compared to females participants (19.85± 7.43), *t* (98) = 2.87, *p* = .021 and Cohen's d =0.42, which means medium effect size. Results are statistically significant and it can be inferred that female gave poor performance in comparison to male while working on the prose memory task. *H_{1a} supported empirically as well as statistically.*

Further, the table shows the mean difference of prose memory task on medium of language. It indicates that there was a decrease in mental effort among participants who was having Hindi medium background (18.49±5.69) in comparison to English medium participants (21.09± 4.62), *t* (98) = 3.83, *p* = .014 and Cohen's d =0.51, which means low effect size. The values indicate that participant's with Hindi as medium of language their performance decreases as mental effort increases in comparison to participants having English as medium of language on prose memory task. *H_{1b} supported empirically as well as statistically.*

This study found that performance while performing Prose Memory Task among right handed participants was high statistic (23.46± 4.76) compared to left handed participants (18.68± 2.31), *t* (98) = 3.45, *p* = .001 and Cohen's d =0.79, which means medium effect size. Results are statistically significant, however, it can be inferred that left-handed participants gave poor performance in comparison to right handed participants on the prose memory task. *H_{1c} supported empirically as well as statistically.*

This study found that performance while performing Prose Memory Task among humanities participants was low statistic (22.45±3.41) compared to science participants (17.66± 5.43), *t* (98) = 4.32, *p* = .032 and Cohen's d = 0.74, which means medium effect size. Results are statistically significant, however, it can be inferred that participants from humanities background gave poor performance in comparison to participants from science background on the prose memory task. *H_{1d} supported empirically as well as statistically.*

Further the mean difference on Prose Memory task based on locality between urban and rural participants. It indicates that there was an increase in mental effort among participants who were having Urban background (21.071 ±7.19115) in comparison to rural participants (16.87± 4.33), *t* (98) = 3.04, *p* = .022 and Cohen's d = 0.64, which means medium effect size while working on prose memory task. The values indicate that participant's from urban

background their performance is high as comparison to participants from rural background on prose memory task. *H_{1e} supported empirically as well as statistically.*

This study found that performance while performing Prose Memory Task among participants having private schooling background was high statistic (22.9 ± 3.35) compared to participants with govt. schooling background (18.07± 3.28), *t* (98) = 3.81, *p* = .064 and Cohen's *d* = 0.72, which means medium effect size. Results are statistically significant, however, it can be inferred that participants with Govt. Schooling background gave poor performance in comparison to participants with private schooling background on the prose memory task. *H_{1f} supported empirically as well as statistically.*

Table 3.3 Independent Samples t-test on Task Difficulty

Mental Effort TD	**N**	**M**	**SD**	***t* (98)**	**Cohn's *d***
Low Effort	49	19.9822	7.55872		
				2.01**	0.49
High Effort	51	21.9922	6.10675		

p.<.01

Table 3.3, shows that High mental effort showed high statistic (21.99 ± 6.10 ms) compared to participants from low mental effort (19.98 ± 7.55 ms), *t* (98) = 2.01, *p* = .01 and Cohen's d = 0.492, which means medium effect size I.e.; as the difficulty and mental effort increases the performance decreases. In current study the overall task difficulty were analysed. It reflects participant's performance decreases as high mental effort needed to complete the task. Results are statistically significant, however, it can be inferred that participants gave poor performance as mental effort increases from low to high on the prose memory task. *H_2 supported empirically as well as statistically.* Further, The Pearson Product-Moment correlation coefficient was computed to measure whether there was a correlation between the mental effort and performance. The scores exhibited a significant negative correlation with the mental effort and performance (*r* = -0.31, *p* <.001). From the results it can be understood that when mental effort increases (linearly) performance decreases. *H_3 supported empirically as well as statistically.*

DISCUSSION

Through the investigation of present study it *concludes* that participant performance decreases when under both high levels of mental demands or overload. In contrast, it is acceptable that cognitive tasks performance will occur optimum at the intermediate levels of mental load. Meanwhile, we anticipate that mental demands may compensate for the reduction in attention limitation due to high mental workload conditions; furthermore, we expect a potential interaction between the types of attention resource pool (verbal/spatial) and task performance with a concurrent both physical and mental demand during the performance. Results showed in table are statistically significant; nevertheless, the mean value indicates that female performance and mental effort was low in comparison to male participants while working on the prose memory task. *H_{1a} supported empirically as well as statistically.* The result of current study was supported by Mohanraj (2005), the study found that academic performance was significantly boys and girls differed in perception of the home and environment. Differences in cognitive performance were observed only in females. The assumption that females respond low sensitively to cognitive load than males appears to be valid (Kakizaki 1987).

The values of the table also reflect that participants from hind background gave poor performance in comparison to participants from English background on the prose memory task. H_{1b} *supported empirically as well as statistically.* The study was sustained by knight and maddens (2010), because of the equipment's are west developers and students who speak English are easily to analysis and understand than Hindi medium language speakers that are way, and their performance is low.

Further, the performance error while performing Prose Memory Task among right handed participants was high statistic compared to left handed participants. Results are statistically significant, therefore, it can be inferred that right handed participants gave better performance in comparison to left handed participants on the prose memory task. H_{1c} *supported empirically and statistically significant.* The study is supported by the Annett (1967) there is an inheritance that people are by nature or biological predisposition related to right-handed and their exploration of things are better than left-handers. Also, the reason is based on perceived demand characteristics depend upon the degree to which a source that is being attended to poses demands on one's processing of hemispheric halves, because information has to be extracted, discriminated among, remembered, and elaborated upon left or right brain side depends on the ability of an individual. (Friedman and Polson; 1981). Moreover, the participants from humanities background gave poor performance in comparison to participants from science background on the prose memory task. H_{1d} *supported empirically as well as statistically.* The study was supported by knight and maddens (2010), the science doctors are having more pressure and cognitive workload than humanities and their performance is better comparatively. Similarly, the values of the table reflect that participants from rural background gave poor performance in comparison to participants from urban background on the prose memory task. H_e *supported empirically as well as statistically.* The study was supported by knight and madden (2010), that urban population can get the things early on and there doing of things are very different as compared to rural background population. Finally, the performance error while performing Prose Memory Task among participants with Govt. schooling background was high statistic compared to participants with private schooling background results was a statistically significant, however, it can be inferred that participants with Govt. Schooling background gave poor performance in comparison to participants with private schooling background on the prose memory task. H_{1f} *supported empirically as well statistically*. The results allow us to conclude that the performance-based assessment criteria result into a higher instructional efficiency, since students in the performance-based condition experience a lower cognitive load during the learning phase which is different from module perspective of Govt. And Private schools, followed by a higher performance on the test task (Annu & Sunita; 2015).

This study found that as the difficulty and mental effort increases the performance decreases. In current study the overall task difficulty were analysed. It reflects participant's performance decreases as high mental effort needed to complete the task. High mental effort showed high statistic compared to participants from low mental effort. Results were statistically significant, however, it can be inferred that participants gave poor performance as mental effort increases from low to high on the prose memory task. H_2 *supported empirically as well as statistically.* The study supported by previous research as shown that as the addition load of drivers are put in the form of music while driving their performance decreases (Mattila & Wirtz; 2001). The study is supported by the Galy & Melan (2015) in the high intrinsic and extraneous load condition, performance was reduced on the morning session (i.e. when alertness was low). Lastly, the correlation between mental effort and

performance was -0.128 with $p < 0.003$. It can be inferred that correlation between mental effort and performance was negative at 0.05 level of significance. From the results it can be understood that when mental effort increases (linearly) performance decreases. *H_3 supported empirically as well as statistically.* Therefore, as the cognitive demands increase so the difficulty to achieve the optimized goal oriented task decreases simultaneously. The study was support by Allen et. al (2013) that there is an inverse relationship in cognitive effort & performance and emotion plays a significant role on it. High cognitive load requires the individual to allocate extra resources to entering information. It is thought that this demand for extra resources may reduce processing efficiency and performance.

The present study has supported the *implementation* and the need of cognitive skills underlying various strategies to develop a goal state. The results of present study provide both solid initial steps toward realisation of individual compatibility framework and, possibly more importantly, strengthening that such an aspect of brain is necessary to perform and enhance cognitive abilities towards mental demands. To utilize imagine codes effectively until they are efficient at verbal and visual encoding; presumably that both visual and verbal code allows effective access or retrieval of information. The findings from this study serve as a foundation on which future research can build to better understand the relationship between mental effort and performance and the need to develop and inherit the strategies to deal with day to day situations efficiently. Additionally, there is a need to start programmes and modules for skill development in relation to working memory capacity and its enhancement during the school years, and indeed free recall performance to improve and open more cognitive resources to assess the ability to adapt their encoding strategy to fit the anticipated memory without preparatory strategies.

The study also recommended that there is a need to strengthen the availability of contextual information to develop better retention measures among students. The contextual information has high impact for reconstruction and recognition of the information explicitly. The present investigation also recommend to develop different modules for different cognitive resources and executive functions to get better understanding about the nature of information processing and problem solving approach.

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Conflict of Interest

The authors were able to come to a consensus with one another, and there were no conflicts of interest recorded.

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