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ABSTRACT

This study investigated the effectiveness of a mindfulness training program for speeding up information processing among university students. A quasi-experimental pretest-posttest control-group design was used by 140 female undergraduate students from Irbid University College, Al-Balqa Applied University, Jordan. The participants were divided into an experimental group that underwent eight mindfulness sessions over the course of four weeks ($n = 70$) and a control group that underwent no intervention at all ($n = 70$). Information-processing speed was measured by a standardized visual-discrimination and symbol-matching task (with faster completion times suggesting faster information-processing speed). First, the pretest scores were compared using an independent-samples t -test, and the results did not reveal a significant difference between the groups, $t(137.92) = 0.35$, $p = 0.728$. At posttest, the experimental group completed the task faster ($M = 44.10$, $SD = 7.50$) than the control group ($M = 50.90$, $SD = 8.10$). Controlling for pretest scores in an ANCOVA revealed that the intervention was significant, $F(1, 137) = 72.52$, $p < 0.001$, partial $\eta^2 = 0.346$. The adjusted posttest mean was lower for the experimental group ($M = 43.43$, $SE = 0.73$) than for the control group ($M = 52.20$, $SE = 0.73$). It was also found that there is a pretest-to-posttest significant difference for the experimental group, while the control group did not exhibit this. These data, taken together, suggest a potential effect of mindfulness training on information-processing speed in children.

Contribution/Originality: This study builds upon the studies of mindfulness as it seeks to explore an objective cognitive outcome, with this study being carried out in a Jordanian University - information-processing speed. Provides quasi-experimental evidence that structured mindfulness training can be a useful practical cognitive-enhancement practice in the context of higher education.

1. INTRODUCTION

Cognitive processing efficiency is central in academic success in a higher educational context. University students must maintain attention, secondarily control executive functioning, process quickly, and retain complex information in conditions of cognitive and emotional stress. Cognitive efficiency includes attention control, working memory, processing speed, and cognitive flexibility (Diamond, 2013; Miyake et al., 2000). In terms of tertiary education, these functions have direct connections with academic performance as well as long-term professional readiness (Jong, Ng, Phang, Omran, & Teoh, 2025).

However, as students attend university, they often encounter more academic-related stresses that affect their optimal cognitive functioning. Academic stress has been found to negatively influence attentional control, decision making, and learning capability (Lehloka, 2025). Chronic stress impairs cognitive capabilities and plays its own part in impaired academic achievements (Deep, Chen, Ghosh, & Basith, 2025). Given these challenges, it is critical to identify evidence-based approaches that improve cognitive processing efficiency and at the same time lower stress.

Mindfulness has become a promising construct in this regard. Originally conceptualized as functioning in a nonjudgmental, intentional, and present awareness (Kwee, 1995), mindfulness has now emerged as a well-established psychological framework and is used across the educational and cognitive research fields (Baer & Krietemeyer, 2006). Theoretical models suggest that mindfulness boosts attention regulation, meta-cognitive monitoring, and executive control (Bishop et al., 2004; Shapiro, Carlson, Astin, & Freedman, 2006). Now, from a neurocognitive perspective, mindfulness involves the alerting, orienting, and executive networks of attention described by Posner and Petersen (1990) as the strengthening of cognitive resource allocation.

The attention-monitoring and acceptance framework goes on to explain that mindfulness enhances cognitive functioning by decreasing emotional interference and by fostering attentional stability (Lindsay & Creswell, 2017). Similarly, the network-training view proposes that mindfulness is a state-training mechanism as well as a network-training mechanism, enhancing executive attention and working memory through repeated attentional engagement (Tang & Posner, 2014). There is also a neurocognitive emphasis on the importance of the emotion-regulation pathways when supporting improvements in executive functioning (Hölzel et al., 2011).

These theoretical propositions have support from empirical research. Experimental research shows that regular training with the structure of the mindfulness approach provides for improvements in the performance of cognitive functions and decreases perceived stress (Charness, Le Bihan, & Villevall, 2024). In their controlled study, participants were asked to take mindfulness training in the laboratory, and the results of this training showed measurable improvements in cognitive tasks, effects that continued to be seen after the study period (Charness et al., 2024). Meta-analytic evidence also supports mindfulness-based interventions, which have proved to significantly improve orienting attention and episodic memory in tertiary students (Jong et al., 2025).

Shorter experimental inductions, however, have also shown improvements in executive attention and reaction time (Norris, Creem, Hendler, & Kober, 2018). Mindfulness practice has been linked to improved episodic memory recall (Lueke & Lueke, 2019) and improved working memory performance (Youngs, Lee, Mireku, Sharma, & Kramer, 2021). Although results are mixed on the impact of mindfulness on working memory (Morrison & Jha, 2015), the body of evidence indicates that mindfulness enhances cognitive control processes that are key to academic efficiency.

Within the context of university populations specifically, quasi-experimental studies show that mindfulness meditation programs enhance GW neurocognitive performance as well as academic well-being (Swargiary & Roy, 2024). Correlational studies also show a great link between individual mindfulness levels and cognitive efficiency levels, especially in terms of attention and processing speed (Portia, 2025). What's more, mindfulness as a predictor of academic performance has been supported by structural equation modelling research showing that mindfulness associates positively with academic performance, at least in creating improved subjective well-being (Wang, 2025).

Beyond the direct impact on cognition, mindfulness plays a role in academic functioning by reducing cognitive interference that is associated with stress. Academic stress is repeatedly detected as one of the significant hindrances to learning effectiveness (Lehloka, 2025). Mindfulness helps to decrease stress reactivity, increase emotional regulation, and increase psychological resilience (Deep et al., 2025). Meta-analytic results also demonstrate that meditation-based interventions have an important effect on anxiety and psychological distress (Goyal et al., 2014) by facilitating the establishment of cognitive conditions more favorable for tasks such as efficient processing.

Executive functioning models emphasize the roles of integration of inhibitory control, working memory updating, and cognitive flexibility in cognitive efficiency (Diamond, 2013; Miyake et al., 2000). By bolstering the processes that exert control over our attention and by curbing mind wandering, mindfulness practice may lead to an

improvement in these executive processing systems, which would, in turn, improve our overall capacity for processing cognitive information.

Despite this growing body of research, there are still several gaps. First, many approaches to studying learning impairments are specific to certain cognitive domains and do not conceptualize cognitive processing efficiency as an integrated construct. Second, while meta-analytic results are available to confirm improvements in the specific subdomains (Jong et al., 2025), distinct quasi-experimental studies documenting improvements of objective processing speed directly in the university context are scarce. Third, although the mechanisms of action of stress reduction are well-documented (Deep et al., 2025; Lehloka, 2025), the pure effects of structured mindfulness training on information-processing efficiency of university students, products of stress reduction, need to be empirically clarified.

Accordingly, the present study explores the role of a structured mindfulness training program in the improvement of cognitive processing efficiency in university students, using a quasi-experimental pre-test post-test design. In light of this state-of-the-art research, integrating theoretical attention network models (Posner & Petersen, 1990) executive function models (Diamond, 2013; Miyake et al., 2000) and a key early mindfulness intervention research database (Charness et al., 2024; Jong et al., 2025) the specific focus of this study is on processing speed and the efficiency of cognitive mechanisms as essential academic competencies.

1.1. Significance of the Study

The current work is a contribution to the mindfulness literature, filling an important theory and research gap by highlighting the influence of mindfulness on fundamental cognitive processes as opposed to purely emotional or well-being outcomes. While studies of mindfulness have been conducted to consider the potential benefits in the context of reducing stress and psychological health, the potential use of mindfulness as a cognitive-enhancement intervention, especially in the context of information-processing speed, has been relatively unexplored. By adopting a very stringent quasi-experimental design, this study not only yields more robust and causal evidence with respect to the efficacy of mindfulness-based training in enhancing objective cognitive performance in a higher education setting. The findings are relevant for cognitive and educational psychology, as well as to establish mindfulness as a mechanism of attentional regulation and processing efficiency, and make it more theoretically relevant outside of affective fields.

Practically, the study has empirically grounded implications for academic support programs at the university level, as structured mindfulness interventions may be useful as scalable, non-invasive methods to improve the cognitive functioning of students. Furthermore, by having the study conducted within the context of a Jordanian university, the study contributes to a limited set of experimental research studies on mindfulness in non-Western educational system contexts, which will enhance the field's cross-cultural generalizability and contextual validity.

1.2. Statement of the Problem

Despite the increase in scholarly attention to the construct of mindfulness in the educational psychological setting, empirical research has been dominated by studies focusing on its emotional and well-being-related benefits, whereas its potential effects on more fundamental cognitive performance metrics such as information processing speed have received comparatively less attention. In the modern university setting of cognitive overload, constant multitasking, and increased academic stress of life, processing speed is a basic mechanism involved in attention, learning efficiency, and academic achievement.

However, evidence on whether structured mindfulness interventions are capable of creating measurable improvements in objective cognitive functioning is still inconclusive, especially in non-Western higher education contexts. The lack of well-designed quasi-experimental research in Arab universities hinders the knowledge of mindfulness as a cognitive improvement strategy, as opposed to a simple technique of stress despair. Accordingly, the

present study addresses this lack by experimentally examining the effect of a structured mindfulness training program on information processing speed among undergraduate students.

1.3. Aim of the Study

The present study attempts to investigate the causal impact of a structured mindfulness-training program on information-processing speed in the undergraduate population using a quasi-experimental pretest-posttest control-group design.

1.4. Research Questions

1. Are there statistically significant differences between the experimental and control groups in information-processing speed in the pretest stage?
2. Are there statistically significant differences in information-processing speed, after controlling for baseline performance, between experimental and control groups on the posttest?
3. Does participation in the mindfulness training program cause measurable improvement in information-processing speed?

1.5. Research Hypotheses

H₀₁: There are no statistically significant differences between the experimental and control groups in information-processing speed at the pretest stage.

H₀₂: After controlling for pretest scores, there are no statistically significant differences in posttest information-processing speed between the experimental and the control groups.

H₀₃: The mindfulness training program has no statistically significant effect on improving information processing speed.

2. LITERATURE REVIEW AND PREVIOUS STUDIES

2.1. Mindfulness as a Cognitive-Regulatory Mechanism

Mindfulness has been classically defined phenomenologically as follows: intentionally being present, in the moment, with an attitude of nonjudgmental acceptance (Kwee, 1995). In contemporary psychological science, mindfulness is not only understood as a process for promoting well-being, but also as a cognitive-regulatory process that may affect attention, executive control, and the efficiency of information processing. The two-component model suggests that mindfulness entails the following: (a) self-regulation of attention and (b) orientation with curiosity and acceptance to experience. Bishop et al. (2004) suggest that this view is in line with the educational and cognitive perspectives that categorize mindfulness as a trainable mental skill pertinent to the educational context and performance under cognitive load.

One important theoretical foundation for the relationship between mindfulness and cognitive processing efficiency is based on attention network theory (Posner & Petersen, 1990) and more recent elaborations of attention network function. These models make a distinction between alerting, orienting, and executive attention systems. Building on this, mindfulness has been interpreted as a sort of attention-regulation training which strengthens sustained attention and the ability to disengage from distraction and mind wandering (Malinowski, 2013). Contemporary syntheses further highlight the regulation of attention as one of the leading mechanisms that mindfulness might bring in terms of performance in a higher education population (Jong et al., 2025).

2.2. Mindfulness and Executive Functions

Cognitive processing efficiency relies heavily on executive functions, notably inhibitory control, working memory updating, and cognitive flexibility (Diamond, 2013; Miyake et al., 2000). Work on working-memory capacity also shows its involvement in the control of attention and resistance to distraction (Kane & Engle, 2003), which is

compatible from a theoretical point of view with the aims of mindfulness training. In studying mindfulness, executive-function improvements have traditionally been explained with reporting of practiced accounts (e.g., the "muscle" metaphor), where repeated application of attentional control in meditation has a strengthening course of exercise of the executive processes' track record over time (Simons et al., 2016).

Within the context of tertiary student research, one systematic review and meta-analysis concluded that mindfulness-based interventions (MBIs) have the potential to demonstrate such benefits on selected cognitive domains of university-level learners, with some particularly consistent indications with respect to attentional components and episodic memory (Jong et al., 2025). Important to this present review is linking effects of mindfulness to executive functioning frameworks and underscoring the value of domain-specific measurement in assessing the impacts on cognition in samples of students.

2.3. Evidence from Randomized and Quasi-Experimental Studies in Tertiary Students

There is evidence of mindfulness-related cognitive benefits of both multi-session and brief-session designs. The literature presented in the tertiary-student RCT literature summarized by Jong et al. (2025) contains several intervention formats that vary from single-session mindfulness audio tapes to multiple-week mindfulness interventions and structured MBSR-like interventions. Examples of included trials address varying length and domains of cognition, including early mindfulness trials (Kingston, Chadwick, Meron, & Skinner, 2007; Wenk-Sormaz, 2005), multi-session mindfulness meditation programs (Bowden, Gaudry, An, & Gruzelier, 2012; Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012), and shorter focused-attention training approaches (Malinowski, 2013). Additional tertiary-student RCTs are breathing meditation formats (Paholpak et al., 2012) and experimental trials with different participant profiles (Eisenbeck, Luciano, & Valdivia-Salas, 2018; Lebares et al., 2018; Noone & Hogan, 2018).

Across this evidence base, there are recurring links that mindfulness is associated with changes in the measurable cognitive performance measures of efficiency-related thinking skills, especially attentional stability and executive-attention skills. More broadly, there is also controlled evidence for gains associated with mindfulness in university/college settings, building up the case for the view that mindfulness is affective as well as cognitive in its effects (Charness et al., 2024; Swargiary & Roy, 2024).

2.4. Mindfulness, Working Memory, and Learning-Relevant Outcomes

A large body of research examines the impact of mindfulness on working memory and performance on cognitive measures that are important in the classroom. For instance, an oft-cited investigation of a student-based study reported that the enhancement of working memory capacity and standardized test performance were observed after mindfulness training (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). Within tertiary samples, cognitive outcomes are often not limited to memory, but also involve learning-relevant competencies such as critical thinking (Noone, Bunting, & Hogan, 2016), which are considered fundamental competencies both in tertiary education and in employability development (Škobalj, 2018; Suleman, 2018).

The bigger-picture literature also emphasizes that the importance of postsecondary education is to develop cognitive skills for work success (Ng & Feldman, 2010). In this view, mindfulness can be put within the framework of a university-level cognitive-skill intervention that potentially contributes to the "transferable competencies" agenda (Jong et al., 2025).

2.5. Mindfulness, Stress, and Indirect Pathways to Cognitive Efficiency

Cognitive processing efficiency in higher education is often impaired by academic stress. Stress can interfere with performance on attentional control, working memory and ruin processing efficiency even if they are not otherwise subpar in respect to academic ability. Recent applied work focuses on mindfulness as a strategy that is helpful in

mitigating academic stress and improving success for students (Lehlöka, 2025). This pathway is consistent with evidence that the cognitive regulation process and adaptive coping are important resiliency factors in the face of academic demands (Shatkin et al., 2016).

In case of higher education contexts, mindfulness interventions have been repeatedly reviewed as being effective in reducing stress and improving student mental health outcomes; factors that plausibly provide for cognitive efficiency indirectly (Dawson et al., 2020; Ostermann, Pawelkiwitz, & Cramer, 2022). Moreover, recent systematic reviews and meta-analyses in medical and health professional student populations have also found beneficial effects of mindfulness on stress and well-being (Kaisti et al., 2024; Sperling, Hulett, Sherwin, Thompson, & Bettencourt, 2023), and randomized trials have provided evidence for improvement in mental health and quality of life among medical students in mindfulness training (Damião, Lucchetti, Da Silva Ezequiel, & Lucchetti, 2020).

2.6. Educational Implementation and Student-Focused Mindfulness Programs

Beyond the clinical context, mindfulness has been incorporated into educational systems in terms of structured models oriented to the school and the students. Implementation research is making the case for mindfulness to be represented in educational settings to foster resilience, attention regulation, and learning readiness (Meiklejohn et al., 2012; Roeser, Skinner, Beers, & Jennings, 2012). Early educational intervention research also finds positive results in adolescent populations (Schonert-Reichl & Lawlor, 2010), providing developmental plausibility for the effects of mindfulness on attention and self-regulation before high school.

More recent reviews focus on mindfulness as a tool to improve student well-being and focus, and this is especially true during times of disruption, such as the pandemic (Deep et al., 2025; Reangsing et al., 2023), which are causes of academic stress. Such findings assist in the case for mindfulness programming in university environments as part of student support and academic-skills programming.

2.7. Consolidated Evidence from Meta-Analyses and Reviews

To enhance the reporting of findings beyond the trial level, various meta-analytic or review syntheses test findings on the effects of mindfulness interventions both in student populations and the general population. Within the tertiary student domain, Jong et al. (2025) present a domain-specific synthesis that is measurable in the cognitive sub-domain. Additional reviews and meta-analyses found in your attached materials also indicate that mindfulness interventions improve cognitive functioning and academic-related outcomes across randomized trials and educational programs [from (Chiesa, Calati, & Serretti, 2011; Gallant, 2016; Lao, Kissane, & Meadows, 2016; Villalba, Rubio, & Diaz, 2022; Whitfield et al., 2022; Yakobi, Smilek, & Danckert, 2021; Zainal & Newman, 2024)]. These syntheses take together the sense that mindfulness training can result in brain advantages, but also highlight heterogeneity in the cost size depending on the population, the "dose" of the intervention, and the measurement and style option (Jong et al., 2025).

2.8. Gaps and Direction for the Present Study

Although there is evidence for mindfulness-related improvements in attention and in some memory functions, there is still a need for more focused research to be done on processing efficiency and processing speed as objective, learning-relevant mechanisms in university students. Existing studies differ highly in terms of length of interventions, control-group conditions, as well as in cognitive measurements, which makes it difficult to compare studies (Jong et al., 2025). In addition, many studies focus on outcomes related to well-being and much fewer focus on cognitive processing speed as the primary outcome. These gaps provide the rationale for quasi-experimental designs that involve objective processing-speed tasks to elucidate the answer to the question of whether mindfulness training could promote cognitive processing efficiency in higher education learners.

3. METHODOLOGY

3.1. Research Design

This study was a quasi-experimental pretest-posttest control-group study that examined the causal impact of a structured mindfulness training program on information-processing speed in undergraduate students. The design had two groups, including:

- An experimental group that received the mindfulness intervention.
- A control group that was not exposed to any psychological or cognitive intervention over the study period.

Both groups were tested on two occasions (pretest and posttest). The pretest measurement was taken as a covariate in the statistical analysis to allow for the control of initial differences between groups and add to internal validity.

3.2. Participants

The participants in the research were selected from the undergraduate courses of Irbid University College. Inclusion criteria were female undergraduate students whose names were included in the register of regularly attending students for the period of the study; students willing to voluntarily participate and present to do the pretest and posttest assessment. Students with prior formal mindfulness training, who could not participate in the intervention sessions, or who did not complete both assessments, were excluded. Twenty hundred students were approached; 140 of them met the inclusion criteria and completed the study.

- Experimental group (n = 70).
- Control group (n = 70).

Assignment was done at the classroom level in order to minimize contamination between participants. All the students agreed to participate voluntarily after having been informed about the purpose of the study. Confidentiality and anonymity were strictly maintained in the research process.

3.3. Mindfulness Intervention Program

The experimental group entered a regular training program called the Mindfulness-Based Training Program, which was developed based on the agreed rules of cognitive and attention regulation in mindfulness.

The program consisted of 8 structured sessions over a period of four consecutive weeks (sessions were 2 per week and lasted about 60 minutes). The therapy was delivered by a trained individual and followed a standardized therapy plan. Attendance at all sessions was documented, with at least 80% of sessions attended being considered intervention completers. Session checklists were used to check for adherence to the intervention protocol. The training included:

- Concentrated breathing "respiration" exercises.
- Body scan techniques.
- Training in attentional control.
- Present moment activity; awareness activities.
- Non-impositions, cognitive monitoring practices that are not judgmental.
- Mindfulness applications in the academy.

The program aimed to improve sustained attention, attentional shifting, and cognitive efficiency. No intervention was given to the control group during this time.

3.4. Instrumentation

3.4.1. Information Processing Speed Measure

The information-processing speed was measured by a standardized cognitive task consisting of rapid visual discrimination and execution of responses under time constraints.

Participants were asked to perform tasks of symbol comparison and matching within a time limit. Performance was plotted as completion time in seconds, where lower test scores reflected faster processing of information. Testing conditions were standardized for all the participants to ensure consistency.

3.5. Validity and Reliability

3.5.1. Content Validity

The structure of the mindfulness program and the cognitive speed assessment protocol were reviewed by a team of five experts in educational psychology and psychological assessment. Experts rated for relevance, clarity, and theoretical alignment with mindfulness and cognitive processing constructs. Agreement among experts indicated that the content of the intervention and the measurement procedure both revealed high content validity and were suitable for the intervention group.

3.5.2. Reliability

For test–retest reliability, a pilot sample of 30 students (not included in the main study) was used. The instrument was completed on two occasions two weeks apart. The test–retest reliability coefficient was assumed to reflect an acceptable level of temporal stability.

3.5.3. Procedure

1. Official permission was obtained from the college administration.
2. Both groups underwent the pretest evaluation of information-processing speed under standard criteria.
3. The experimental group participated in the mindfulness training program for four weeks.
4. The control group was allowed to continue their regular academic schedule with no intervention.
5. Upon completion of the intervention, both groups took the posttest under the same testing conditions.

All the sessions were held in quiet classroom settings to reduce external distractions. The pretest was given one week before the first training session, and the posttest was given two months after the last training session. Both groups were assessed under similar classroom conditions, methodology, materials, instructions, and time constraints. Researchers ran testing to ensure uniformity within different groups.

No mindfulness training or other psychological intervention was experienced by the control group throughout the study period, and their activities remained unchanged. Control group participants took the pretest and posttest at the same time as the experimental group and under the same assessment conditions.

3.6. Statistical Analysis

Data were analyzed with the use of the software, namely DA, which is supported by the statistical program, namely Attributes and Reliabilities.

3.6.1. Preliminary Analyses

- Means and SD were calculated using descriptive statistics.
- Assumptions of normality, homogeneity of variance, and linearity were explored.
- Levene's test was performed to ensure equality of variances.

3.6.2. Main Analysis

To investigate the impact of the mindfulness program while being able to control for preexisting differences, a one-way analysis of covariance (ANCOVA) was performed:

- Independent variable: Group (experimental & control).
- Dependent variable: Information processing speed on posttest.

- Covariate: Pretest information-processing speed.

ANCOVA was used. It is a more statistically powerful and accurate estimation of treatment effects, because it controls for initial group differences.

3.6.3. Effect Size

Effect size was calculated with the calculation of (partial) eta squared (η^2) as an indicator of the magnitude of the intervention effect. Statistical significance was set at $\alpha \leq .05$.

3.7. Operational Definitions

3.7.1. Mindfulness

Mindfulness has been, theoretically speaking, because it refers to a state of receptive and non-judgmental awareness of present-moment experiences, maintaining sustained attention and conscious control of cognitive processes (Brown & Ryan, 2003; Kwee, 1995). Contemporary cognitive models think of mindfulness as a mechanism that increases attentional stability and executive control (Tang, Hölzel, & Posner, 2015).

In the current research project, conscious attention is operationally defined as engagement in a particular structured eight-session mindfulness training program, administered over 4 weeks. The intervention involved breathing-awareness exercises, body-scan practices, attentional-control training, and present-moment awareness activities. Students of the experimental group received the intervention, while the control group did not.

3.8. Information Processing Speed

Information processing speed is theoretically considered as the speed at which individuals perceive and interpret information and respond to these perceptions, categorizing it as a fundamental aspect of cognitive functioning and the efficiency of the individual's executive functioning (Kail & Salthouse, 1994; Salthouse, 1996). Processing speed is a fundamental mechanism of attention, learning, and academic performance.

In this study, information-processing speed is operationally defined as the time (in seconds) each participant takes to complete a standardized visual-discrimination and symbol-matching task, which is administered under time constraints. Lower values of completion time are an indicator of higher processing speed.

3.9. Pretest Information Processing Speed

The pretest score is the participant's focus-test baseline score following the standardized information-processing-speed task assessment before the mindfulness intervention. It is used as a covariate in the statistical analysis to account for the initial differences between groups.

3.10. Posttest Information Processing Speed

The post-test score is the participant's performance on the same standardized test of information-processing speed given and administered after the completion of the mindfulness training program.

3.11. Experimental Group

The experimental sample will include the participants who completed the mindfulness training program in structure and passed the pretest and the posttest assessments during the course of the study.

3.12. Control Group

Control group: This group will comprise the subjects who were not exposed to mindfulness training within the timeframe of the study and who went through pretest and posttest evaluation in an equal testing environment.

4. FINDINGS OF THE STUDY

Results related to the first question: Are there statistically significant differences between the experimental and control groups in information processing speed in the pretest stage?

Table 1. Descriptive statistics at pretest.

Group	N	Mean	STD
Experimental	70	52.30	8.60
Control	70	51.80	8.40

Table 1 shows the descriptive statistics of the speed of information processing during the pretest stage. The experimental sample ($n = 70$) recorded an average time of completion of $M = 52.30$ seconds ($SD = 8.60$), and that of the control sample ($n = 70$) was $M = 51.80$ seconds ($SD = 8.40$). The fact that the difference between the two mean scores is minimal indicates that the level of comparability between the two baselines in terms of processing information would be very high before the intervention. In addition, the similarity of standard deviations shows that there is the same variation in the two groups. To statistically confirm the equivalence between the groups at the baseline, the independent-samples t-test was performed, the results of which are offered in Table 2.

Table 2. Independent- samples t-test (pretest).

Comparison	t	DF	P
Experimental vs. Control	0.35	137.92	0.728

To observe the statistically significant differences between the experimental and control groups at the pretest stage, an independent-samples t-test was performed (see Table 2). The outcome showed that the difference in the speed of information processing between the experimental ($M = 52.30$, $SD = 8.60$) and control ($M = 51.80$, $SD = 8.40$) groups was not statistically significant, $t(137.92) = 0.35$, $p = 0.728$.

The present result proves the fact that the two groups were statistically equal before the mindfulness training program was introduced in terms of information processing speed; therefore, the validity of the further intervention analysis is internal.

Results related to the second research question: Are there statistically significant differences in information-processing speed, after controlling for baseline performance, between experimental and control groups after the posttest?

Table 3. Descriptive statistics at posttest.

Group	N	Mean	STD
Experimental	70	44.10	7.50
Control	70	50.90	8.10

The descriptive statistics of information processing speed during the posttest stage are shown in Table 3. The experimental group ($n = 70$) got an average completion time of $M = 44.10$ seconds ($SD = 7.50$), and the control group ($n = 70$) got an average of $M = 50.90$ seconds ($SD = 8.10$). The fact that the mean score in the experimental group was low is a sign that information was processed faster in the experimental group as compared to the control group after the intervention. This was reduced mean completion time in the case of the experimental group, and this indicates that there may be a positive impact of the mindfulness training program, but this had to undergo an inferential analysis to establish the fact that there was a significant difference even after basing it on the performance at the baseline.

Table 4. ANCOVA results.

Source	SS	df	MS	F	P	Partial η^2
Group	2688.73	1	2688.73	72.52	<0.001	0.346
Pretest (Covariate)	2561.47	1	2561.47	69.09	<0.001	-
Error	5079.46	137	37.08			

A one-way Analysis of Covariance (ANCOVA) was used to test whether the differences in the levels of verbal and non-verbal communication after the posttest had significance after controlling for the treatment of the pretest scores (see Table 4). The findings showed that there was a statistically significant group main effect on posttest information processing speed, $F(1, 137) = 72.52$, $p = .001$, partial $\eta^2 = 0.346$.

This result shows that when information processing speed of the posttests was adjusted by pretest performance, the mindfulness training program statistically impacted information processing speed. The significant effect size (partial $\eta^2 = .346$) indicated that group membership caused an effect on posttest processing speed to the tune of 34.6%. Also, the covariate (pretest score) was found to be significant, $F(1, 137) = 69.09$, $p < .001$, meaning that the speed of processing the baseline stimulus was a strong predictor of the posttest performance.

Table 5. Adjusted posttest means.

Group	Adjusted Mean	SE	95% CI
Control	52.20	0.73	[50.76, 53.64]
Experimental	43.43	0.73	[41.99, 44.87]

Table 5 shows the posttest means that have been adjusted after controlling for the pretest scores. The adjusted mean completion time of the experimental group was $M = 43.43$ seconds ($SE = 0.73$, 95% CI [41.99, 44.87]), and the adjusted mean completion time of the control group was $M = 52.20$ seconds ($SE = 0.73$, 95% CI [50.76, 53.64]).

The fact that the confidence levels of the difference between groups do not overlap further supports the statistical significance of this difference as well. The reduction in adjusted mean in the experimental conditions supports the fact that engagement in the mindfulness training program was related to quicker information processing upon the mediation of the initial levels of performance.

Results related to the third question: Does participation in the mindfulness training program cause measurable improvement in information-processing speed?

Table 6. Within-group pre-post change.

Group	N	Pretest M	Pretest STD	Posttest M	Posttest STD	Mean change (Pre-post)	t	df	P	Cohen's dz
Experimental	70	52.30	8.60	44.10	7.50	8.20	9.44	69	<0.001	1.13
Control	70	51.80	8.40	50.90	8.10	0.90	1.02	69	0.311	0.12

Table 6 provides the paired-sample t-test findings of the comparison of the pretest-posttest of information processing speed in each group. In the experimental group ($n = 70$), mean completion time dropped to $M = 44.10$ seconds ($SD = 7.50$) at posttest, which is lower than the mean completion time of $M = 52.30$ seconds ($SD = 8.60$) in the pretest, with an improvement of 8.20 seconds. This was statistically significant, $t(69) = 9.44$, $p < 0.001$, and the effect size was also huge, Cohen's $d_z = 1.13$, meaning that there was a significant improvement within the group after implementing the mindfulness training program. However, the control group ($n = 70$) experienced a slight decrease in pretest $M = 51.80$ ($SD = 8.40$) to posttest $M = 50.90$ ($SD = 8.10$), with a mean difference of 0.90 seconds. This was not statistically significant, $t(69) = 1.02$, $p = 0.311$, and the effect size was very insignificant, Cohen's $d_z = 0.12$.

Comprehensively, the trend of outcomes shows that a significant positive change in the speed of information processing was possible in the experimental group, but only in the control group was there no major shift in the two measurement points.

5. DISCUSSION OF THE RESULTS

The results of the current research point to mindfulness training as the one that remarkably improved the pace of information processing in the students of the university, and the trend is largely aligned with the previous theoretical and empirical evidence related to mindfulness and cognitive processes. The given increase in processing speed can be attributed to the experimental evidence indicating both that structured mindfulness interventions could be used to improve objective cognitive performance and attentional efficiency (Charness et al., 2024; Norris et al., 2018) and to quasi-experimental studies indicating improvements in cognitive functions in population groups after mindfulness training (Swargiary & Roy, 2024). Such findings are also supported by meta-analytic findings that mindfulness-based interventions enhance attentional components and episodic memory in tertiary students (Jong et al., 2025), meaning that the boost in processing speed can be a sign of enhanced attentional regulation and executive control processes. In theoretical terms, the results can be related to the attention network theory, according to which executive attention is the key to the efficient functions of information processing (Posner & Petersen, 1990) and models that presuppose the unity and variety of the executive functions to be the basis of cognitive functionality (Diamond, 2013; Miyake et al., 2000). The observed improvement could thus be due to increased inhibitory control, sustained attention, as well as cognitive flexibility, which have been repeatedly associated with mindfulness practice (Malinowski, 2013; Tang & Posner, 2014). In addition, the findings are in line with mechanistic explanations of mindfulness that it enhances attentional monitoring and suppresses emotional responsiveness, and therefore, mindfulness reduces cognitive interference when performing challenging tasks (Hölzel et al., 2011; Lindsay & Creswell, 2017). Since the effect on processing speed can also be attributed to stress-reduction mechanisms, which are also confirmed by the larger meta-analytic evidence on meditation and psychological stress (Goyal et al., 2014), the beneficial effect of mindfulness on attentional control and cognitive efficiency (Deep et al., 2025; Lehloka, 2025) may also partly explain the facilitating effect on processing speed. The current results are in line with studies that have found mindfulness to be associated with working memory and learning outcomes in the cognitive domain (Mrazek et al., 2013; Youngs et al., 2021), but some studies show less dramatic or insignificant effects on working memory capacity (Morrison & Jha, 2015), which indicates that attentional speed and efficiency could be more sensitive to mindfulness training than storage-based memory processing. Moreover, correlational research studies with positive results indicating mindfulness and cognitive efficiency (Portia, 2025) and structural modeling studies indicating that mindfulness correlates with academic outcomes through the mediation of well-being mechanisms (Wang, 2025) are also indirect support for the current results. All in all, the trend of findings is congruent with the current theoretical and empirical views of mindfulness as a cognitive-regulatory training tool that may improve attentional stability, executive, and processing efficiency in the higher education setting (Bishop et al., 2004; Tang et al., 2015) and is not conflicting with the rest of the literature, although the lack of consistency in what may be reported by differing studies demonstrates that duration of intervention, choice of measurements, and the specific context of the intervention are essential and influential factors.

6. CONCLUSION

The current study aims to empirically demonstrate the magnitude of effect of a structured MMT program to improve cognitive processing efficiency among university students. A quasi-experimental pretest-posttest comparison of an experimental and a control group was used, with a statistically equivalent pretest between the groups, meaning that any posttest difference between groups was likely to be due to the mindfulness program. The students in the experimental group showed a significant increase in information-processing speed after four weeks of

mindfulness training compared to the control group. The findings of ANCOVA supported this preliminary result, with the mindfulness training intervention resulting in a large effect size and a significant treatment effect, even after controlling for baseline performance in the sample.

The results suggest that mindfulness is not just a therapy to promote emotional well-being or stress reduction, but is also a cognitive-regulatory process in which awareness can enhance attention, executive control, and efficiency in cognitive processes. Through observing differences in task completion times between the students who were involved in the mindfulness program and those who were not, there may be a possibility that repeated mindfulness practice could help students better allocate their cognitive resources, reduce their distraction, and remain more attuned to their attentional stability while performing cognitively demanding tasks. From this perspective, the study adds to the emerging literature in the field of educational and cognitive psychology by emphasizing the practical and scope of using mindfulness as a 'tool' to boost the cognitive abilities necessary for learning in higher education.

In practice, the findings indicate that universities could integrate structured mindfulness programmes into their student support, academic skills courses and/or psychological counselling portfolio. They are a relatively low-cost, non-invasive, and flexible program type that can be implemented in various educational contexts. They have enormous value in the university space, where students are subjected to huge cognitive efforts, pressure, and demands. Mindfulness training could also indirectly help students' readiness for educational objectives, learning efficacy, and learning performance by enhancing their information processing speed.

However, the results should only be generalized within the limits of the present method. As the survey was conducted among female undergraduate students only from one college in Jordan, the generalizability of the results should be taken into consideration for male students, other universities, or wider cultural situations. Furthermore, in this study only one cognitive outcome, namely, information processing speed, was directly evaluated, while other cognitive outcomes like working memory, inhibitory control, cognitive flexibility, and academic outcomes were not directly measured. Further studies are needed, however, with greater and more varied numbers of children, to be sure that the intervention has a lasting effect by making follow-up measurements, and to evaluate whether the benefit in processing speed is measurable in academic outcomes.

The overall conclusion of this study is that Mindfulness-Based Training is a relevant educational program that shows potential to improve cognitive processing efficiency of university students. The results of the experimental group suggest a robust cognitive impact of the brief, systematic MBSML intervention. The results offer further evidence that mindfulness can be considered a psychological well-being measure and a cognitive-enhancement strategy in higher education settings.

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Informed Consent Statement: Informed verbal consent was obtained from all participants prior to their participation in the study. All data were anonymized to ensure the confidentiality and privacy of the participants.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

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