

The Impact of DBT-Based Mindfulness Training on Cognitive Performance among University Students: A Pre-Post Stroop Test Study

Shumaila Atif¹ , Sheeba Farhan², Rabika Shoukat¹, Sara Jehangir¹

¹College of Clinical Psychology, Faculty of Allied Health Sciences, Ziauddin University, Karachi, Pakistan

²Assistant Professor, Department of Psychology, FUUAST, Abdul Haq Campus

ABSTRACT

Background: Mindfulness is increasingly used to support cognitive and emotional functioning in high-stress academic settings. Dialectical Behavior Therapy (DBT) combines mindfulness with distress tolerance, cognitive flexibility, and emotion regulation skills that may strengthen attentional control. However, controlled evidence using objective cognitive measures remains limited in South Asian university populations.

Methods: A one-group pre-test–post-test design was used with 50 undergraduate students (aged 18–25 years) purposively recruited from a Pakistani university. Participants completed the Stroop Color and Word Test (SCWT) before and after a structured six-session DBT-based mindfulness training program covering core mindfulness, distress tolerance, cognitive flexibility, and stress-management skills. Pre- and post-intervention scores on nine SCWT indices were compared using paired-samples t-tests.

Results: Word-reading time fell significantly, from 15.19±5.19 to 12.89±3.93 seconds ($t(49)=2.691$, $p=0.010$), as did letter-reading time, from 32.38±10.07 to 26.10±9.33 seconds ($t(49)=3.596$, $p=0.001$), and letter-reading errors, from 0.74±0.99 to 0.40±0.78 ($t(49)=2.084$, $p=0.042$). Color-naming time, the remaining error scores, and all three interference (conflict) scores showed no significant change (all $p>0.05$).

Conclusion: A brief DBT-based mindfulness program improved basic processing speed and selective attention but left higher-order executive control and interference resolution largely unchanged. The training is a feasible, low-cost way to strengthen foundational attentional processes in university students. However, longer or more intensive programs may be needed to affect more complex executive functions.

Keywords: Attention; Executive Function; Dialectical Behavior Therapy; Mindfulness; Self-regulation.

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Corresponding Email: shumaila.atif@zu.edu.pk

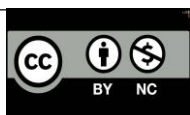
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INTRODUCTION

University life brings academic workload, performance pressure, and major life changes, all of which draw heavily on students' attention and self-regulation. Mindfulness-based interventions have become common in higher education for exactly this reason, and meta-analytic evidence shows they produce small-to-moderate improvements in student distress, anxiety, and dispositional mindfulness compared with passive controls¹. Related work suggests that mindfulness training also builds resilience, which in turn softens the psychological impact of academic stress².

Mindfulness does more than ease distress; it has also been linked to change in core cognitive

processes such as attention and cognitive flexibility. A meta-analysis of 87 studies found that meditation practice most reliably strengthens the brain's executive-control network, with weaker and less consistent effects on alerting and orienting³, and cognitive flexibility itself is now understood as a trainable capacity supported by fronto-parietal brain networks⁴. Even a single guided mindfulness session has been shown to speed up Stroop task reaction times in people with no meditation experience⁵, and comparable single-session studies have found matching gains in conflict-resolution speed alongside changes in frontal neural activity measured through functional near-infrared spectroscopy⁶.



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Dialectical Behavior Therapy (DBT) pair mindfulness with distress tolerance, cognitive flexibility, and emotion regulation skills, and its group-based skills format has moved well beyond its clinical origins into non-clinical, help-seeking groups⁷. Reviews of DBT skills groups report modest but consistent benefit across several stress- and regulation-related outcomes⁸, and stand-alone DBT skills protocols have reduced impulsivity-related behavior in non-clinical adult samples^{9,10}. The mindfulness module of DBT trains people to notice thoughts and sensations without judgment and to keep returning attention to the present moment, what DBT calls the “Wise Mind.” That skill set maps fairly directly onto what the Stroop Color and Word Test (SCWT) demands: overriding an automatic reading response in favor of a slower, less automatic color-naming response, which is essentially a behavioral test of selective attention and inhibitory control.

Even so, the evidence on whether brief mindfulness training changes objective cognitive performance, rather than just self-reported mindfulness or distress, is mixed. Several brief, online, or single-module programs report gains in processing speed and attention with no matching change in higher-order executive control^{11–13}, and a recent 31-day randomized trial found that an online program improved mindfulness and metacognition but produced no measurable change on any cognitive or affective outcome¹⁴. A systematic review of mindfulness-based interventions in tertiary students reached a similar conclusion, describing cognitive benefits as inconsistent across trials and generally backed by low-quality evidence¹⁵.

In Pakistan, adapted mindfulness training has already shown good feasibility and acceptability in reducing student stress¹⁶. However, controlled evidence of its cognitive effects, measured objectively rather than through self-report, remains limited. This study examines whether a brief, structured DBT-based mindfulness training program changes cognitive performance, specifically processing speed, selective attention, and interference control, in university students, using a pre-test–post-test design with the SCWT as the main outcome measure.

METHODOLOGY

Design

This study used a one-group pre-test–post-test design to track changes in cognitive

performance following a structured DBT-based mindfulness training program, comparing each participant's own scores before and after training rather than against a separate control group.

Participants

Fifty undergraduate students aged 18–25 were recruited from a Pakistani university through purposive sampling. To be included, students had to be enrolled full-time, fall within the target age range, and have no history of neurological illness or psychotropic medication use. Anyone with a current, diagnosed neurological or psychiatric condition, or prior formal mindfulness or DBT training, was excluded. The final sample (24 male, 26 female) spanned all four undergraduate years and four broad fields of study (Table 1); most participants lived with family (72%) in nuclear households (62%).

Measures

Cognitive performance was measured with the Stroop Color and Word Test (SCWT), a long-established neuropsychological measure of selective attention, processing speed, and inhibitory control. Participants read printed words, read color names printed in mismatched ink, and named the ink color itself while trying to suppress the more automatic reading response^{6,14}. This produced nine indices in total: time and error scores for word reading, letter reading, and color naming, plus three interference (conflict) scores capturing the cost of overriding the dominant reading response.

Intervention

The intervention ran across six weekly sessions of about 90 minutes each, preceded by a baseline orientation session. Training moved from core mindfulness skills and “Wise Mind” awareness, through distress-tolerance skills (STOP, TIPP), cognitive flexibility and mindful decision-making exercises, and finally to stress management and relaxation techniques such as progressive muscle relaxation and paced breathing, and concluded with a consolidation and evaluation session. Combining mindfulness with distress-tolerance and emotion-regulation modules in this way is the standard DBT skills-training format, and it has already shown measurable benefit for impulsivity- and stress-related outcomes in non-clinical and student samples^{8,9}. Participants kept homework logs between sessions to support daily practice, and each session began with a brief group review of what they had noticed since the last session.

Procedure

The SCWT was administered individually in a quiet, distraction-free room before the first training session and again after the sixth session, by an assessor who was not involved in delivering the sessions. Participants were identified only by code throughout the study, and they were free to withdraw at any point without penalty.

Ethical Considerations

Prior to data collection, the study protocol was approved by the Foundation Research Forum Institutional Review Board (IRB No. 2025/056). Before participating in the study, all participants were informed of its purpose, procedures, and voluntary nature, and then signed informed consent forms. All data were coded rather than named, and confidentiality was respected during data processing and analysis; data were processed only for research purposes.

Statistical Analysis

The data was analyzed using SPSS. Sample descriptive (means, standard deviations, and frequencies) were used to summarize the sample, and paired-samples t-tests were used to compare the pre- and post-intervention scores across each of the nine indices of the SCWT, with a significance level of $p < 0.05$.

RESULTS

Table 1 summarizes the sample's demographic profile ($N=50$). Participants were fairly evenly spread across academic years, close to an even gender split (48% male, 52% female), and represented social sciences, business and management, medical and health sciences, and computer sciences.

Table 1. Demographic Characteristics of Participants ($N = 50$)

Variable	Category	n	%
Age Group	18–20 years	18	36.0
	21–23 years	22	44.0
	24–25 years	10	20.0
Gender	Male	24	48.0
	Female	26	52.0
Academic Year	1st Year	12	24.0
	2nd Year	15	30.0
	3rd Year	13	26.0
	4th Year	10	20.0
Field of Study	Social Sciences	16	32.0
	Business & Management	12	24.0
	Medical & Health Sciences	11	22.0
	Computer Sciences	11	22.0
Family System	Nuclear	31	62.0
	Joint	19	38.0
Residence Status	Hostel	14	28.0
	Living with Family	36	72.0

Table 2 sets out the paired-samples t-tests comparing pre- and post-intervention SCWT scores. Word-reading time dropped from 15.19±5.19 seconds at pre-test to 12.89±3.93 seconds at post-test ($t(49)=2.691$, $p=0.010$), and letter-reading time dropped from 32.38±10.07 to 26.10±9.33 seconds ($t(49)=3.596$, $p=0.001$). Letter-reading errors also fell, from 0.74±0.99 to 0.40±0.78

($t(49)=2.084$, $p=0.042$). Color-naming time decreased but not significantly ($t(49)=1.435$, $p=0.158$), and neither word-reading errors ($p=0.860$) nor color-naming errors ($p=0.288$) changed. None of the three interference (conflict) scores, for words, letters, or color, shifted significantly either (all $p>0.05$), though the letter-conflict score came close to a significant increase ($t(49)=-1.941$, $p=0.058$).

Table 2. Paired-Samples t-Test for Pre- and Post-Intervention Stroop Color and Word Test Scores (N = 50)

Variable	Pre-Test M (SD)	Post-Test M (SD)	t (49)	p
Time – Read Words (s)	15.19 (5.19)	12.89 (3.93)	2.691	0.010*
Time – Read Letters (s)	32.38 (10.07)	26.10 (9.33)	3.596	0.001**
Time – Say Colour (s)	23.14 (9.28)	20.98 (6.51)	1.435	0.158
Errors – Read Words	0.24 (0.52)	0.22 (0.55)	0.178	0.860
Errors – Read Letters	0.74 (0.99)	0.40 (0.78)	2.084	0.042*
Errors – Read Colour	0.96 (1.11)	0.70 (1.34)	1.074	0.288
Conflict – Words	1.04 (0.20)	1.06 (0.24)	-0.444	0.659
Conflict – Letters	1.06 (0.24)	1.16 (0.37)	-1.941	0.058
Conflict – Colour	1.40 (0.50)	1.46 (0.50)	-0.724	0.472

* $p<0.05$, ** $p<0.01$

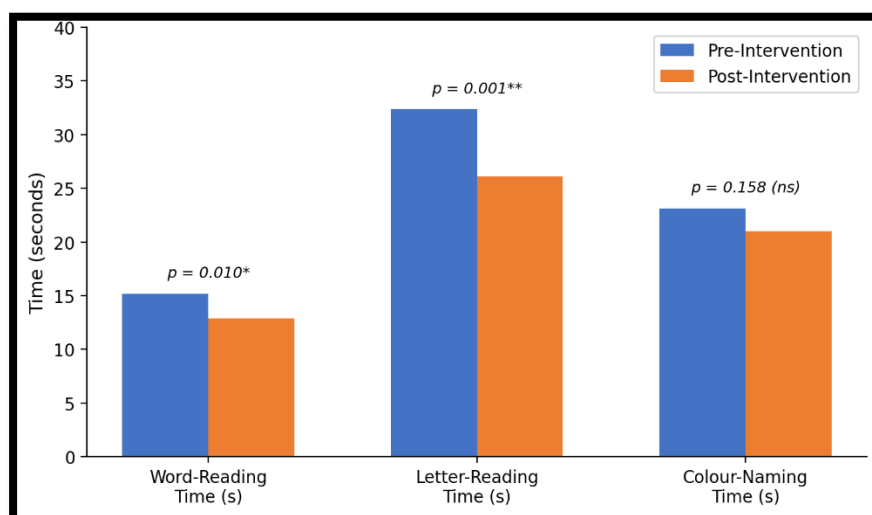


Figure 1 shows this pattern across the three timed indices. Word-reading and letter-reading times both fell after the intervention, while color-naming time barely moved, suggesting the benefit sat mainly in the more automatic reading tasks rather than the harder color-naming task.

Combined, this suggests a moderate improvement in basic processing and selective attention (word- and letter-reading time) and in letter-reading errors but not in any corresponding measures of color-naming, in

the more challenging errors, or in interference resolution.

DISCUSSION

This study aimed to determine whether a brief, structured mindfulness training program based on DBT affects objective cognitive function in university students. The first of these hypotheses was supported: training was significantly correlated with enhanced processing speed and selective attention in both word and letter reading, as well as fewer letter-reading errors. The second hypothesis

was only partially supported, as the scores for color-naming and the more difficult error scores did not increase or decrease, nor did the three interference scores, indicating that the training did not significantly impact higher-order executive control.

These results fit a wider, and increasingly mixed, literature on mindfulness and cognition. Brief and digital mindfulness formats have repeatedly helped student mental health and self-reported attention problems¹⁷⁻²¹, and a similar short programme for nursing students improved perceived stress and dispositional mindfulness over eight weeks¹². But direct transfer to standardized cognitive tasks looks less dependable: a recent 31-day randomized trial found gains in mindfulness and metacognition but nothing on any cognitive or affective measure¹⁴, and a systematic review of mindfulness interventions in tertiary students came to a similar conclusion, calling the cognitive evidence inconsistent and generally weak¹⁵. What we found here, improvement on the simpler, more automatic reading measures but not on colour-naming or conflict resolution, fits that pattern, and may simply reflect how short six sessions is next to the sustained practice usually needed to move higher-order inhibitory control¹³.

The gain on basic processing measures makes sense given what the DBT mindfulness module actually trains: present-moment, non-judgmental observation, which is close to the sustained, undistracted attention that speeds up simple word- and letter-reading. Single-session and brief mindfulness protocols have produced similar acute gains in reaction time and conflict-resolution speed on the Stroop task in non-clinical samples²²⁻²³, which supports this explanation. The lack of change on interference scores fits, too; mindfulness-based stress-reduction work has reduced experiential avoidance and impulsivity without necessarily touching more effortful control processes over a short intervention window²⁴. A comparable pattern turns up in a randomized trial of mindfulness-based stress reduction, which protected academic persistence without changing how students appraised academic stressors, suggesting mindfulness training can help with specific, narrow outcomes without reshaping everything about how students function²⁵.

Strengths

Compared with subjective self-report, this study employed an objective, standardized neuropsychological measure (SCWT);

provided a manualized DBT intervention with explicit session content; and employed a within-participant design that controlled for differences in cognitive ability among individuals at baseline. The short duration and group nature of the program also make it possible to run it as a routine university counseling service.

Limitations

No control/comparison group was used in this study, reducing the ability to determine cause-and-effect; some of the improvement may be due to practice effects (taking the SCWT twice) rather than the intervention. The findings are not generalizable beyond the one sampled institution, were non-random, and only six sessions were conducted, which may not have been sufficiently long to measure change in higher-order executive functions. Similarly, using only one behavior, without a self-report or a neurophysiological measure to accompany it, provides limited insight into the results.

Recommendations

Future research should employ randomized designs with active or waitlist comparison groups to control for differences due to repeated testing and to distinguish the effect of the intervention itself from that of repeated testing. The longer, more intensive DBT-based mindfulness programs should be studied to determine whether changes in interference control and other higher-order executive functions are possible after sustained practice. Larger samples with more sites across varied disciplines and institutions would improve generalizability, and the SCWT could be combined with self-report mindfulness measures and, if available, neurophysiological measures (e.g., EEG or fNIRS) to provide more information about cognitive change.

CONCLUSION

This study showed that a six-session, short DBT-based mindfulness training program had a significant effect on basic processing speed and selective attention performance, measured by the Stroop Color and Word Test word reading and letter reading times, but had a negligible effect on interference control and color naming times, the more challenging error measures, in university students. Teaching basic attentional skills with DBT might be a viable and cost-effective intervention in academic contexts, whereas it is premature to overestimate its efficacy for higher-order executive functions. It is reasonable to suggest that a short mindfulness intervention, developed using DBT, can be incorporated into counseling and study-skills courses as

interventions to support students' cognitive and emotional well-being; however, longer and more controlled trials are required to determine if longer-term mindfulness practice can expand these benefits to more complex executive-control processes that have a greater impact on academic outcomes.

Author Contributions

Shumaila Atif conceived and designed the study, contributed to data collection, and supervised the research process. **Sheeba Farhan** assisted in study design, data analysis, and interpretation of results. **Rabika Shoukat** contributed to the literature review, manuscript drafting, and critical revision. **Sara Jehangir** assisted in data collection, manuscript editing, and final approval of the manuscript. All authors reviewed and approved the final manuscript.

Ethical Approval

The study protocol was approved by the Foundation Research Forum Institutional Review Board (IRB No. 2025/056).

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None.

Conflict of Interests

None.

REFERENCES

- Dawson AF, Brown WW, Anderson J, Datta B, Donald JN, Hong K, et al. Mindfulness-based interventions for university students: a systematic review and meta-analysis of randomised controlled trials. *Appl Psychol Health Well Being*. 2020 Jul;12(2):384-410. <https://doi.org/10.1111/aphw.12188>
- Bajaj B, Khoury B, Sengupta S. Resilience and stress as mediators in the relationship of mindfulness and happiness. *Front Psychol*. 2022 Feb 3;13:771263. <https://doi.org/10.3389/fpsyg.2022.771263>
- Sumantry D, Stewart KE. Meditation, mindfulness, and attention: a meta-analysis. *Mindfulness*. 2021 Jun;12(6):1332-49. <https://doi.org/10.1007/s12671-021-01593-w>
- Uddin LQ. Cognitive and behavioural flexibility: neural mechanisms and clinical considerations. *Nat Rev Neurosci*. 2021 Mar;22(3):167-79. <https://doi.org/10.1038/s41583-021-00428-w>
- Sleimen-Malkoun R, Devillers-Réolon L, Temprado JJ. A single session of mindfulness meditation may acutely enhance cognitive performance regardless of meditation experience. *PLoS One*. 2023 Mar 15;18(3):e0282188. <https://doi.org/10.1371/journal.pone.0282188>
- Elcin D, Velasquez M, Colombo PJ. Effects of acute and long-term mindfulness on neural activity and the conflict resolution component of attention. *Front Hum Neurosci*. 2024 Feb 21;18:1359198. <https://doi.org/10.3389/fnhum.2024.1359198>
- Delaquis CP, Joyce KM, Zalewski M, Katz LY, Sulymka J, Agostinho T, et al. Dialectical behaviour therapy skills training groups for common mental health disorders: a systematic review and meta-analysis. *J Affect Disord*. 2022 Mar 1;300:305-13. <https://doi.org/10.1016/j.jad.2021.12.062>
- Villalongo Andino M, Garcia KM, Richey JA. Can dialectical behavior therapy skills group treat social anxiety disorder? A brief integrative review. *Front Psychol*. 2024 Jan 8;14:1331200. <https://doi.org/10.3389/fpsyg.2023.1331200>
- Cavicchioli M, Movalli M, Bruni A, Terragni R, Elena GM, Borgia E, et al. The initial efficacy of stand-alone DBT skills training for treating impulsivity among individuals with alcohol and other substance use disorders. *Behav Ther*. 2023 Sep 1;54(5):809-22. <https://doi.org/10.1016/j.beth.2023.02.006>
- Warner N, Murphy M. Dialectical behaviour therapy skills training for individuals with substance use disorder: a systematic review. *Drug Alcohol Rev*. 2022 Feb;41(2):501-16. <https://doi.org/10.1111/dar.13362>
- Devillers-Réolon L, Masclet N, Sleimen-Malkoun R. Online mindfulness intervention, mental health and attentional abilities: a randomized controlled trial in university students during COVID-19 lockdown. *Front Psychol*. 2022 Jul 7;13:889807. <https://doi.org/10.3389/fpsyg.2022.889807>
- Liu YL, Lee CH, Wu LM. A mindfulness-based intervention improves perceived stress and mindfulness in university nursing students: a quasi-experimental study. *Sci Rep*. 2024 Jun 8;14(1):13220. <https://doi.org/10.1038/s41598-024-64183-5>
- Zhong SY, Guo JH, Zhou XN, Liu JL, Jiang CL. Effects of brief mindfulness meditation training on attention and dispositional mindfulness in young adult males. *Acta Psychol (Amst)*. 2024 Jun 1;246:104277. <https://doi.org/10.1016/j.actpsy.2024.104277>
- Thomson JS, Van Hedger SC. Influence of a brief online mindfulness intervention on metacognition, cognition, and emotional outcomes among university students: a randomized longitudinal trial. *Psychol Int*. 2025 Jul 9;7(3):60. <https://doi.org/10.3390/psychoint7030060>
- Jong FJ, Ng AL, Phang CK, Omran S, Teoh SL. The effects of mindfulness-based intervention on cognitive functions in tertiary students: a systematic review and meta-analysis. *Appl Cogn Psychol*. 2025 May;39(3):e70056. <https://doi.org/10.1002/acp.70056>
- Sarraz A, Siddiqui S, Galante J, Sikander S. Feasibility and acceptability of an online mindfulness-based intervention for stress reduction and psychological wellbeing of university students in Pakistan: a pilot randomized controlled trial. *Int J Environ Res Public Health*. 2023 Apr 14;20(8):5512. <https://doi.org/10.3390/ijerph20085512>
- Reangsing C, Abdullahi SG, Schneider JK. Effects of online mindfulness-based interventions on depressive symptoms in college and university students: a systematic review and meta-analysis. *J Integr Complement Med*. 2023 May;29(5):292-302. <https://doi.org/10.1089/jicm.2022.0606>
- Chen B, Yang T, Xiao L, Xu C, Zhu C. Effects of mobile mindfulness meditation on the mental health of university students: systematic review and meta-analysis. *J Med Internet Res*. 2023 Jan 3;25:e39128. <https://doi.org/10.2196/39128>
- Küchler AM, Schultchen D, Dretzler T, Moshagen M, Ebert DD, Baumeister H. A three-armed randomized controlled trial to evaluate the effectiveness, acceptance, and negative effects of StudiCare mindfulness, an internet- and mobile-based intervention for college students with no and "on demand" guidance. *Int J Environ Res Public Health*. 2023 Feb 11;20(4):3208. <https://doi.org/10.3390/ijerph20043208>
- El Morr C, Ritvo P, Ahmad F, Moineddin R; MVC Team. Effectiveness of an 8-week web-based mindfulness virtual community intervention for university students on symptoms of stress, anxiety, and depression: randomized controlled trial. *JMIR Ment Health*. 2020 Jul 17;7(7):e18595. <https://doi.org/10.2196/18595>
- Ritvo P, Ahmad F, El Morr C, Pirbaglou M, Moineddin R; MVC Team. A mindfulness-based intervention for student depression, anxiety, and stress: randomized controlled trial. *JMIR Ment Health*. 2021 Jan 11;8(1):e23491. <https://doi.org/10.2196/23491>

22. Yamaya N, Ikeda S, Hoshino Y, Takeuchi H, Kawashima R. Temporal changes in the state effect of meditation on response inhibition processes. *Mindfulness*. 2023 Mar;14(3):554-64. <https://doi.org/10.1007/s12671-022-02064-6>
23. Devillers-Réolon L, Temprado JJ, Sleimen-Malkoun R. Mindfulness meditation and bimanual coordination control: study of acute effects and the mediating role of cognition. *Front Psychol*. 2023 May 15;14:1162390. <https://doi.org/10.3389/fpsyg.2023.1162390>
24. Qomi NJ, Sharifi T, Zadeh SM, Ahmadi R. Examining the efficacy of mindfulness-based stress reduction training on experiential avoidance and impulsivity in female students with difficulty in emotional regulation. *J Appl Psychol Res*. 2024;15(1):149-67. <https://doi.org/10.22059/JAPR.2024.330421.643988>
25. Baumgartner JN, Schneider TR. A randomized controlled trial of mindfulness-based stress reduction on academic resilience and performance in college students. *J Am Coll Health*. 2023 Jul 24;71(6):1916-25. <https://doi.org/10.1080/07448481.2021.1950728>