Psychology Research and Behavior Management

Dovepress

open access to scientific and medical research

Open Access Full Text Article

HYPOTHESIS

The Role of Trait and State Mindfulness in Cognitive Performance of Male Adolescents

Andrea Firth[1,2], Stefan Sütterlin[3,4], Ricardo Lugo[4,5]

[1]University Campus Football Business, London, UK; [2]Headgame Performance Psychology, London, UK; [3]Faculty of Computer Science, Albstadt-Sigmaringen University, Albstadt, Germany; [4]Faculty of Health, Welfare and Organisation, Østfold University College, Halden, Norway; [5]Estonian Maritime Academy, Tallinn University of Technology, Tallinn, Estonia

Correspondence: Andrea Firth; Ricardo Lugo, Email andrea@headgame.co.uk; ricardo.g.lugo@ntnu.no

Purpose: The number of mindfulness intervention projects is continually increasing. Within the educational environment, mindfulness has purported links to well-being, positive behaviour, educational and cognitive performance. Trait mindfulness is related to rational thinking and better performance in cognitive tests, suggesting that innate mindfulness ability contributes to self-regulation ability and thus the efficacy of mindfulness interventions. The current study investigates whether mindfulness is a moderating factor. It examines correlations between cognitive performance and trait mindfulness. The study investigates the influence of trait mindfulness on the ability of students to enter state mindfulness in an attempt to understand the role both types of mindfulness may have on cognitive performance.

Participants and Method: Two-hundred and five male students aged fifteen and sixteen completed the adolescent version of the Mindfulness Awareness Scale, the Cognitive Reflection Test, and the Toronto Mindfulness Scale.

Results: Hierarchical regression analysis found that state mindfulness was a predictor of cognitive reflection ability. ANOVA also found that having either trait or state mindfulness predicted higher cognitive reflection scores, but only state mindfulness had a significant effect on cognitive reflection. Trait mindfulness was not a moderating factor.

Conclusion: Both state and trait aspects of mindfulness ability influence cognitive performance. Those with higher trait mindfulness ability are better able to enter state mindfulness and thus had better cognitive reflection scores. However, where it is possible to induce state mindfulness into those with low trait mindfulness, CRT scores were also higher although not significantly so.

Keywords: trait mindfulness, state mindfulness, cognitive reflection

Introduction

There are numerous definitions and types of meditation practices, one of them being mindfulness. The multifaceted nature of mindfulness practices[1] makes it difficult to define.[2] Nonetheless, a widely accepted definition describes mindfulness as being able to focus in a non-judgmental fashion on in-the-moment reality[3,4] often on internal and external experiences[2] without distraction, whilst simultaneously remaining open-minded.[3] In short, it is a self-regulated state in which focus is sustained by the impedance of judgmental appraisal[5] resulting in a self-induced state of relaxation.[6]

The number of mindfulness intervention projects in UK schools is continually increasing with projects such as The Mindfulness in Schools Initiative (https://mindfulnessinschools.org/) set up as a non-for-profit organization in 2009 contributing to this growth. The Department for Education (DfE) encouraged 150 schools to run trials allowing mindfulness and relaxation classes in UK schools in order to enhance wellbeing.[7]

Such initiatives are because of evidence that mindfulness, seemingly, has widespread advantages within educational environments.[8–10] Findings from a review of thirty-five studies on mindfulness within schools support this view and found that there were cognitive benefits,[11] including the improvement of executive function of primary school students with low executive functioning.[12]

Received: 18 March 2023
Accepted: 17 August 2023
Published: 22 September 2023

The interest in using mindfulness interventions within education is also growing internationally.[13] Such programmes typically include focused breathing[14] and awareness of senses where students are encouraged to adopt mindfulness as a way of life. Whilst mindfulness has been purported to improve with practice[15] and trait mindfulness predicts the ability to recover from conflict[16] it can also be a negative experience for some adolescents who try to practice it. Due to this age group finding it challenging to be too aware of themselves, coupled with a lack of understanding how awareness works for this sample.[17] Young adolescent students (aged 11–14) find mindfulness least beneficial. Developmental and neurological differences may be the reason for the lack of success in this age group.[18] Mindfulness interventions in late adolescence (age 15–18) have more positive results on mental health.[19] Irrespective of age, mindfulness practice is not a beneficial experience for everyone, not least for trauma victims where the use of mindfulness can lead to iatrogenic harm.[20] Furthermore, mindfulness used in word memory tests can lead to errors due to false memory.[21,22] A recent meta-analysis on the efficacy of mindful-based programs (MBP) in schools shows that while MBP's do not improve interpersonal skills in school children, MBP's have small effects (hedges g = 0.19) on academic performance and small to moderate effects on attention (hedge's g = 0.31)[22] but this study focused on mindfulness delivery and not individual differences.

Given the growth of mindfulness use within schools, the current study investigates mindfulness interventions within the school context. Whilst mindfulness has not been beneficial for all adolescent age groups,[17] the age group under investigation in the current study is most likely to benefit from mindfulness interventions. However, success is dependent on various factors including individual differences.[19] The current study purports that individual differences may include natural mindfulness ability (trait mindfulness), which may go some way in explaining the disparity in the efficacy of mindfulness interventions. The role of trait mindfulness, a natural propensity towards mindfulness,[23] within such settings has largely been ignored. Thus, the role of trait mindfulness in enhancing the benefits of mindfulness practice should be further explored.

The Efficacy of Trait Mindfulness

The function of trait mindfulness has been demonstrated with links to several behavioural and emotional factors. Trait mindfulness has been found to have a high to moderate correlation with emotion regulation (r = −.67), negative affect (r = −.47), positive affect (r = 0.44), trait anxiety (r = −.62), depression (r = −.46), and resilience (r = 0.55).[24] The cognitive processes involved in trait mindfulness have been shown to be significantly correlated to rational thinking (r = 0.56), with acting mindfully as one of the main predictors of rational thinking.[25] However, not everyone is receptive to mindfulness, and it is not necessarily beneficial to all. Innate reason may include natural mindfulness ability (trait mindfulness) and the impact this has on the capacity to enter state mindfulness, which may explain why mindfulness works for some and not others.

Cognitive inhibition as measured by the Cognitive Reflection Test[26] is related to cognitive processes in terms of how well the individual can suppress irrelevant information and stay on task.[27] The CRT measures the ability to inhibit the tendency to go with incorrect intuitive responses and instead reflect on the correct response with a clear link to academic ability.[28] There is also a link between cognitive performance and mindfulness[11] as well as cognitive inhibition.[29] Furthermore, mindfulness and cognitive reflection ability share common traits; both mindfulness[30] and CRT results[26] are associated with self-regulation in the form of the ability to delay gratification. As mindfulness seems correlated with a number of qualities, due to its multifaceted nature,[31] the current study investigates whether mindfulness ability and CRT are correlated with each other and if trait mindfulness is a moderating factor. Cognitive inhibition is positively correlated to academic achievement and moderated via cognitive load.[32]

Mindfulness is correlated with academic performance.[33,34] However, such findings are not consistent. When the Mindfulness Attention Awareness Scale,[23] a measure of trait mindfulness was used to investigate whether trait mindfulness was positively related to academic performance, no such correlations were found.[35] This was supported by a meta-analysis which also found that mindfulness interventions did not significantly improve academic grades (p = 0.08) but both studies ignored the role which trait mindfulness, or lack thereof, might have contributed in these findings.[11] This is especially pertinent as the findings of these two pieces of research are at odds with other research using mindfulness as an intervention, which found significant correlation between mindfulness and academic performance. For example, in adolescent participants with learning difficulties, aged between thirteen and eighteen years old, a 5–10-minute mindfulness intervention at the

beginning of every class for five days lasting five weeks increased academic performance.[36] Other research supports these findings, focused breathing, an element of mindfulness, administered for fifteen to twenty minutes, bi-weekly for eight weeks was found to improve overall academic performance but had the best results when combined with psychological interventions in improving science, mathematics and English subjects amongst eleven to sixteen-year-old English students.[37] Ninety minutes of mindfulness once per week over ten weeks also improved academic results.[38] Albeit with exceptions, a general consensus is therefore found that mindfulness is beneficial in improving educational performance. Whilst various improvements are seen within schools who are adopting mindfulness approaches, it is far from convincing that the mechanism behind such approaches is solely due to the mindfulness intervention used. The contrast in these findings may be due to underlying trait mindfulness ability, which allows positive findings where participants have strong mindfulness traits and negative findings, where participants have poor mindfulness traits.

Regulation of Behaviour

Self-regulation, the ability to regulate cognition, emotions and behaviour, is argued to be a key component in predicting academic success in adolescents.[38–40] It is also linked to mindfulness as both incorporate the ability to remain in the moment concentrating on the current task.[41] Mindfulness enhances self-reflection by engaging a less reactive mode of brain functioning.[42] Mindfulness is also associated with more adaptive antecedent emotion regulation strategies[43] and increases cognitive capacity.[44]

Mindfulness is both a top-down and bottom-up cognitive process. Less experienced mindfulness practitioners are more top–down in their emotion regulation, while more experienced practitioners are more bottom–up.[45] Top-down support can be seen through lateral prefrontal cortex activation and decreased amygdala activity,[46] while bottom-up processes show decreased prefrontal activation associated with top-down processes.[45,47] Both processes suggest that prefrontal–limbic interactions are present. These two processes are not conflicting but might show how changes from novice level to expert levels of mindfulness use can lead to a change from top-down process to more bottom-up. The determination of the approach one might be more predisposed to use is also dependent on the age of a person. Either process may be adaptive, but physiological maturation alongside directed experiences using mindfulness will be better predictors.[48] Nonetheless, mindfulness has shown to increase executive control through either regulating emotional influence on anxiety,[43] increasing attentional control,[45] and increasing cognitive reappraisal while decreasing emotional suppression.[48] Taken together, increasing mindfulness has beneficial factors to cognitive processes.

The link between CRT and academic performance has been demonstrated by various research.[28,49] Specifically, CRT is positively correlated with numeracy skills[50] and contrary to the findings of Campitelli and Labollita,[51] who found that general knowledge and not mathematical ability is correlated to CRT results, most research has found a significant relationship, between CRT and mathematical ability.[49] Furthermore, a moderate correlation between CRT and academic SAT scores was reported between r = 0.40 and .45.[26,52]

Due to the demonstrable link between CRT and academic performance, the current study deems CRT an appropriate measure to indicate both inhibitory cognitive processes and possible academic performance. The cognitive reflection test (CRT) is a unique measure of cognitive impulsivity, or one's tendency to rely primarily on intuitive or deliberative processes.[26] The test both measures differences in cognitive abilities and detects individual differences in participants' tendencies to use more intuitive (eg automatic) versus deliberative (controlled, analytical) processes during problem solving. Specifically, in problem solving,[26] described cognitive reflection as the ability to override erroneous intuitive responses and instead engage in further reflection that increases the chances of arriving at the correct response. This ability can be predictive of decision-making choice but is not a valid measure of cognitive ability.[53,54] However, it is related to a number of cognitive and executive thinking tasks.[52]

To establish the role of trait and state mindfulness in cognitive performance, the current study first investigates (H_1) whether CRT performance and trait mindfulness ability are correlated. Secondly, (H_2) it seeks to understand whether those with higher trait mindfulness ability perform state mindfulness better than participants with lower trait mindfulness ability. Thirdly, (H_3) it is expected that those students who have higher trait mindfulness ability and can self-regulate to enter state mindfulness, will do better in the CRT test than those who are lower in trait mindfulness ability and who are less able to enter state mindfulness.

Method

Participants and Design

Participants were two hundred and ten male students from a boys grammar school in Kent, England, aged fifteen to sixteen and based in the southeast of England. Whilst the school is a boys grammar school they allow girls into the sixth form (age 16–18). The school population is comprised of 93% boys and 7% girls based on 1610 students. All the participants of the study were 15 to 16 years old and thus below the age where girls were allowed in the school. The study was conducted in collaboration with the school who were interested in ways to improve academic performance and self-regulation of students about to take GCSE examinations. All participants were about to take their GCSEs that summer. The school is in a middle-class catchment area. The ethnic composition of the school is 45.5% White, 9.4% Black, 31.5 Hispanic, 3% Asian, 10.6% other. The study did not collect ethnicity demographics, as the study was not investigating race-related data. The school has an Ofsted rating of good, meaning it is outstanding in most of the key areas, with few areas requiring improvement. Of the 225 students in the cohort, 210 agreed to take part in the study and signed the paperwork. All but five of the participants fully completed the measures, so the data of n = 205 participants could be used in data analysis.

A correlational approach was used since all students were participating in the research to test the effects of a mindfulness intervention on performance.

Ethical Procedure

Ethical permission was granted from the University of Greenwich (ethical approval reference number, UREC/10/11.3.5.1). Written consent forms from parents and the school, along with assent forms from the participants were obtained in the preceding weeks. Where consent was not gained, or students changed their mind on the day, students were given the option not to engage with the mindfulness exercises, or to engage but their data would not be collected.

Measures and Materials

Mindfulness Videos & Practice

Participants were informed of the purpose of the study, and the concept of mindfulness was explained via a YouTube clip (https://youtu.be/JDSIfNLlFds) and practiced via a five-minute mindfulness video (https://youtu.be/YFSc7Ck0Ao0). The MAAS-A and the Toronto Mindfulness Scale were administered, followed by the CRT.

Trait Mindfulness Measurement

The Mindful Attention Awareness Scale – Adolescent (MAAS-A)[55] is a scale with good internal consistency based on a reported Cronbach's alpha of 0.86. It is a fourteen item, six-point Likert Scale questionnaire ranging from "Almost Always to Almost Never". Scores can range from 15 to 90 with higher scores reflecting higher levels of trait mindfulness. It was developed from the Mindful Attention Awareness Scale, MAAS,[23] which also had high internal consistency, Cronbach's alpha 0.82. It measures the ability of individuals to remain in the present moment during everyday tasks. The MAAS has been found to be related to dissociation and absent-mindedness and concerns mindfulness in terms of how receptive the individual is to present experience. It is able to measure both the existence and non-existence of trait mindfulness and is the most commonly used mindfulness scale.[55] The MAAS is also positively correlated with judgement and decision-making ability.

State Mindfulness Measurement

Toronto Mindfulness Scale, TMS[56] is a thirteen item self-report measure of mindfulness based on five-point Likert scale ranging from "Not at all" to "Very Much". It measures two dimensions or mindfulness curiosity and decentering, with subscale scores ranging from 0–24 and 0–28, respectively, with higher scores indicating higher state mindfulness ability than lower scores. It has a high internal consistency with Cronbach's alpha of above 0.80, according to these authors. It measures state mindfulness in terms of the ability to reflect and to engage in self-observation rather than participate in contemplative practices such as focused breathing. The TMS is used immediately after a mindfulness or meditation

session to indicate how well participants are able to reflect on their, in the moment, mindfulness ability and is suitable for use with adolescent populations.

Cognitive Performance

The Cognitive Reflection Test, CRT,[26] is a three-item problem-solving test aimed at highlighting how well participants can override the temptation to give instinctive but incorrect answers and arrive at the reflective and correct answer. It is a predictor of performance on heuristics tasks and although it is a measure, at least in part, of cognitive ability, it measures miserly processing, ie, the propensity to engage in mental short cuts.[52]

Procedure

Informed consent was gathered in the weeks preceding the data collection. Data collection for the study was included as part of an all-day extracurricular event. The school-day began at 8.50am with classroom registration, followed by the school assembly, an activity and a short break that concluded at 9.50am. The data collection for the study began at 10am, lasting a total of ninety minutes. Circa 225 students gathered in the main hall, where all participants were briefed on the purpose of the study, with the concept of mindfulness explained via a YouTube clip (https://youtu.be/JDSIfNLlFds). Those students who had signed the consent forms completed the Mindful Attention Awareness Scale – Adolescent (MAAS-A).[56] Their teachers subsequently divided the participants into groups of 75, with non-participants invited to help their teachers in another part of the school. To ensure integrity in the data collection process, each of the consenting participant groups were separated into non-adjoining rooms. Each group engaged in a five-minute mindfulness exercise activity instructed via video (https://youtu.be/YFSc7Ck0Ao0). After the video, each participant completed the Toronto Mindfulness Scale followed by the CRT. The order of the three questions for the CRT was randomly rotated between the six possible combinations, ensuring that all participants in the group received questions in a random order. Having first been given sight of the questions and allowed to read them through (45 seconds), the participants had two minutes and twenty-five seconds to complete the three answers. This was to ensure all participants had equal time to answer the questions whilst ensuring they were not hampered by individual reading speed. Furthermore, the researcher was on a narrow time restriction dictated by the school in which to complete all sets of data collection. The researcher then moved to the next classroom and repeated the process until all participants had completed the tasks.

Data Analysis

Statistical analysis was done with SPSS v.26. For the regression analysis, a hierarchical regression analysis was performed where state mindfulness was entered in the first step, trait mindfulness in the second step and the total CRT score as the dependent variable. Both trait and state mindfulness were divided into low/high groups using a median split. Then, Analysis of Variance was used to compare the combination of low/high state and trait mindfulness and the group differences on CRT Performance. The significance level was set to 0.05.

Results

Descriptives and correlations for all variables can be found in Table 1.

Students' results comprising no correct answers were the most common response amongst this cohort, followed by students gaining one correct answer, then students who got all three questions correct. Those who achieved two out of three correct answers were the smallest group (see Table 2).

Table 1 Descriptives and Correlations for All Variables

	Mean	SD	1	2	3
1. CRT	1.11	1.0	-		
2. bTMS	17.60	11.92	−0.248*		
3. MAAS-A	53.15	12.96	−0.084	−0.226**	–

Notes: *Correlation is significant at 0.05 level (1-tailed). **Correlation is significant at 0.01 level (1-tailed).

Table 2 Frequency of Correct Responses on the CRT Scores

		Frequency	Percent
Correct CRT answers	0	79	38.5
	1	59	28.8
	2	32	15.6
	3	35	17.1
	Total	205	100.0

Table 3 Group (Low/High State/Trait Mindfulness) and CRT Scores

Group	N	Mean	SD
Low TMS/Low MAAS	44	0.84	0.96
Low TMS/High MAAS	61	1.41	1.12
High TMS/Low MAAS	54	1.02	1.11
High TMS/High MAAS	46	1.09	1.15
Total	205	1.11	1.09

Abbreviations: TMS, Toronto Mindfulness Scale; MAAS, Mindfulness Attention Awareness Scale.

To test whether the two independent variables (H_1), state mindfulness (Toronto Mindfulness Scale, TMS)[57] and trait mindfulness (Mindful Attention Awareness Scale – Adolescent, MAAS-A) could predict CRT scores, a hierarchical regression analysis was performed where state mindfulness was entered in the first step and trait mindfulness in the second step. The results show that only state mindfulness ($\beta = 0.238$, $t = 3.35$, $p < 0.001$) was significant and predicted 6.1% of the total model ($F = 6.61$, $p = 0.002$, $R^2 = 0.061$). Therefore, based on total score results the hypothesis that participants scoring higher in cognitive reflection will have higher state and trait mindfulness ability is only partially accepted.

The strength of the relationship between CRT results and state mindfulness was hypothesized (H2) to be dependent upon the level of trait mindfulness (MAAS-A). It was expected that those students with high trait mindfulness would also display the ability to readily enter state mindfulness and consequently do better on the CRT test. Both state and trait mindfulness were split into low and high groups to see their interaction on the CRT. Four groups were then created, low state/low trait (N = 44), low state/high trait (n = 61), high state/low trait (n = 54), and high state/high trait (n = 46). Median values for the splits were as follows: for trait mindfulness scores lower than 17.60 on the TMS were considered low, while for state mindfulness, scores lower than 53.15 were categorized as low. After categorization, a χ^2 test of association was conducted to analyse the distributions of students across the groups (H2). Students were evenly distributed between the groups (χ^2 (205) = 3.00, $df = 1$, $p = 0.083$), and higher trait mindfulness could not be associated with higher state scores.

It is hypothesized that (H_3) students high in trait and in state would do better than students low on both factors. A Kruskal Wallis non-parametric ANOVA was conducted. The independent variables were trait and state mindfulness, and the dependent variable was CRT scores. The results were not significant ($F(3, 4) = 7.56$, $p = 0.056$, $\eta^2 = 0.10$; see Table 3 for group statistics), but did show trends. Having either high trait or state mindfulness predicted higher scores on the CRT (See Table 3), but higher trait mindfulness (MAAS-A) was necessary to related to higher scores.

Discussion

This study aimed to see how both trait and state mindfulness influenced performance on a cognitive reflection task. We expected that pupils high on both factors would perform better than less mindful pupils. The results partially supported

the hypothesis. In keeping with our expectation that trait mindfulness would influence the relationship between the CRT results and state mindfulness, we found that although high trait mindfulness was needed for better scores on the CRT it was not significant and only state mindfulness could directly predict better scores.

Regardless of trait mindfulness states, students able to gain a higher mindfulness state produced greater correct scores on the CRT (Table 3). High trait mindfulness groups did show tendencies to outperform all other groups regardless of state mindfulness.

These results show that mindfulness has an influence on cognitive performance, as also reported by Farrar and Tapper,[25] but adds that state measurements must also be included in future research, in line with Zuckerman[57] recommendations that both trait and state factors should be included. When we controlled for trait dimensions of MF, state dimensions were still significant in predicting CRT scores, partially supporting the hypothesis. The current study supports the argument put forward by Zuckerman[57] that both state and trait MF may have separate influences. Results of studies on eating behaviours[58] elicited similar findings pertaining to the roles of trait and state mindfulness. State mindfulness could predict healthier eating behaviour, while trait measurements were mildly related to healthier eating behaviour.

While trait mindfulness might explain general tendencies in behaviour, state mindfulness may better explain situational differences in behaviour. Similar findings regarding state versus trait tendencies have been found in other cognitive domains, i.e., self-efficacy and resilience[59] indicating that state measurements better predict behaviour. Being induced into a state of mindfulness can stop maladaptive cognitions, such as rumination, and thus free up attentional resources that can be used on other tasks.[43] The results from this study support this hypothesis.

These results add to previous research supporting that increased mindfulness predicts better performance. While the cognitive reflection task (CRT) is not an academic test, it has predictive power of academic achievement.[26] Having higher trait mindfulness combined with the ability to induce higher state mindfulness resulted in increased performance on the CRT, supporting previous research on academic performance. Mindfulness may work on attention on two different cognitive systems, reappraisal and attentional control[45] or by increasing executive function efficiency. Trait measurements and their influence on the results support the premise of mindfulness helping top-down processes such as reappraisal.[43,45,48,60] Inducing higher states of mindfulness helps through more bottom-up processes such as increased attentional control and the downregulation of emotional influence.[43,48,60]

Mindfulness, regardless of which cognitive process it may influence, may increase more reflective cognitions. The design of CRT challenges slower but more rational cognitions, and not emotional and quicker cognitions in decision-making. The results from this study show that the low trait/state group performed the worst, but higher states of mindfulness, either trait or induced, scored best. It was expected that the high trait/state group would have scored best, but this was not the case. Participants in the highest scoring group (low state/high trait), and those high in trait mindfulness, might not need the induction to perform better. The high trait mindfulness group might already be efficient in their reflections through bottom-up processes. Inducing them into more mindful states might initiate clashes in having both dominant top-down and bottom-up processes, therefore weakening performance. This distinction is only present in the high trait mindfulness group, while low trait mindfulness groups performed worse. Inducing mindfulness to high trait mindful people may have the same effect as when trying to control well-learned automatic behaviours, otherwise known as choking-under-pressure. Increased expertise requires little attention with well-practiced cognitions easily accessed. Whilst newer scenarios require more attention and more sequential processing.[61] Inducing mindfulness might make more automatic cognitions become more conscious. Therefore, slowing down efficient well-rehearsed procedural cognitions that one previously did with minimal mental resources.

Performance improvement occurs with better awareness of the current situation, thus metacognitive awareness is a predictor for cognitive performance. Individuals with low trait MF can increase cognitive performance with a short-term MF intervention,[62] as the results of this study also show. However, interfering with the natural ability to be generally mindful by trying to induce a higher mindfulness state might be detrimental. Research showing the beneficial effects of mindfulness[45,47,48] might only reflect low trait mindfulness participants, as no distinction was made between trait and states.

The current study is one of the few that have incorporated both trait and state measurements and the results showed conflicting results. To understand the effects of induced mindfulness better, more research will have to incorporate both trait and state measurements. Similar to Baer et al,[36] in the current study, mindfulness has the potential to increase academic performance. Other research supports these findings, focused breathing, an element of mindfulness, administered for fifteen to twenty minutes, bi-weekly for eight weeks was found to improve overall academic performance but had best results when combined with psychological interventions in improving science, mathematics and English subjects amongst eleven to sixteen-year-old English students.[37] Similar results occur in different countries amongst comparably aged students. One such study in Spain involved a one hour and thirty minutes' mindfulness intervention once per week for ten weeks and, likewise, improved academic results.[38]

Mindfulness enhances self-reflection by engaging a less reactive mode of brain functioning.[42] Mindfulness is also associated with more adaptive antecedent emotion regulation strategies[43] and has been shown to increase cognitive capacity.[44] Cognitive inhibition is related to cognitive processes in terms of how well the individual can suppress irrelevant information and stay on task.[27] Cognitive inhibition is positively correlated to academic achievement moderated via cognitive load.[32] The Cognitive Reflection Test[26] measures the ability to inhibit the tendency to go with incorrect intuitive responses and reflect on the correct response and is linked to academic ability.[28] There is also a link between cognitive performance and mindfulness[11] as well as cognitive inhibition in children.[29] Furthermore, mindfulness and cognitive reflection ability share common traits, such as both mindfulness[29] and CRT[26] are associated with self-regulation in the form of the ability to delay gratification. As mindfulness seems correlated with a number of qualities, due to its multifaceted nature,[31] the current study is interested in investigating if mindfulness ability and CRT are correlated with each other and also, if trait mindfulness is a moderating factor. Given the link between cognitive processes, mindfulness and academic success, the role of trait mindfulness ability, in this regard, requires further examination.

Limitations

A subset of high trait mindfulness but low state MF scored better than all others. This could be caused by third variables not taken into account in this research. Other factors such as IQ, cognitive styles or familiarity with the CRT could explain these results.

The participants were males only, and qualitative developmental differences at the age of fifteen and sixteen can have an influence on the results. Fifteen and sixteen-year-old males may vary in terms of their competence, self-regulation, and mindfulness.

State mindfulness was only measured post mindful induction. Participants changes in state mindfulness were thus not recorded, and it cannot explain if the induction worked to lower state mindfulness.

Students were controlled for when they received the mindfulness intervention. Students were divided into three groups and one group at a time was given the intervention, while the other two had extracurricular activities. Students receiving the intervention at the end, may have been more exhausted or aroused, thus not receiving the full benefit of the intervention.

Conclusion

This study showed that mindfulness had positive benefits on outcomes, but the results must be viewed with caution. Mindfulness, as shown in this study, is not just a trait that can be influenced, state measurements were better at predicting performance, and must be taken into account, as mindfulness might not only be beneficial for people who are generally more mindful. Conversely, a mindfulness intervention might make well-rehearsed cognitions more accessible and therefore less susceptible to cognitions like underperformance. This study shows that both trait and state mindfulness can have positive influences on cognitive performance suggesting that even people low on trait mindfulness can have positive effects of short mindful interventions.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Chawla N, Collins S, Bowen S, et al. The mindfulness-based relapse prevention adherence and competence scale: development, interrater reliability, and validity. *Psychother Res*. 2010;20(4):388–397. doi:10.1080/10503300903544257
2. Brown KW, Ryan RM, Creswell JD. Addressing fundamental questions about mindfulness. *Psychol Inq*. 2007;18(4):272–281. doi:10.1080/10478400701703344
3. Kabat-Zinn J. *Mindfulness Meditation for Everyday Life*. London, UK: Piatkus; 2001.
4. Thompson BL, Waltz JA. Mindfulness, self-esteem, and unconditional self-acceptance. *J Ration*. 2008;26:119–126. doi:10.1007/s10942-007-0059-0
5. Bishop SR, Lau M, Shapiro S, et al. Mindfulness: a proposed operational definition. *Clin Psychol*. 2004;11(3):230.
6. Kozasa EH, Lacerda SS, Menezes C, et al. Effects of a 9-day shamatha Buddhist meditation retreat on attention, mindfulness and self-compassion in participants with a broad range of meditation experience. *Mindfulness*. 2015;6:1235–1241. doi:10.1007/s12671-015-0385-8
7. Sharman J. Eight-year-olds to get mindfulness lessons to promote wellbeing. *Retrieved*. 2017;9:2019.
8. Hyland T. The limits of mindfulness: emerging issues for education. *Br J Educ Stud*. 2016;64(1):97–117. doi:10.1080/00071005.2015.1051946
9. Schoeberlein D, Sheth S. *Mindful Teaching and Teaching Mindfulness*. Boston, Wisdom Publications); 2009.
10. Weare K. Mindfulness and contemplative approaches in education. *Curr Opin Psychol*. 2019;28:321–326. doi:10.1016/j.copsyc.2019.06.001
11. Maynard B, Solis M, Miller V, Brendel K. Mindfulness-based interventions for improving cognition, academic achievement, behaviour, and socioemotional functioning of primary and secondary school students. *Campbell Syst Rev*. 2017;2017:5.
12. Flook L, Smalley SL, Kitil MJ, et al. Effects of mindful awareness practices on executive functions in elementary school children. *J Appl Sch Psychol*. 2010;6(1):70–95. doi:10.1080/15377900903379125
13. Khng KH. Mindfulness in education: the case of Singapore. *Learn Res Pract*. 2018;4(1):52–65.
14. Khng KH, van Reekum C. A better state-of-mind: deep breathing reduces state anxiety and enhances test performance through regulating test cognitions in children. *Cogn Emot*. 2016;30:1–9. doi:10.1080/02699931.2016.1103011
15. Solloway SG, Fisher WP Jr. Mindfulness in measurement: reconsidering the measurable in mindfulness practice. *Int J Transpers Stud*. 2007;26(1):8.
16. Grundy JG, Krishnamoorthy S, Shedden JM. Cognitive control as a function of trait mindfulness. *J Cogn Enhanc*. 2018;2(3):298–304. doi:10.1007/s41465-018-0065-4
17. Tharaldsen K. Mindful coping for adolescents: beneficial or confusing. *Adv Sch Ment Health Promot*. 2012;5(2):105–124. doi:10.1080/1754730X.2012.691814
18. Johnson C, Burke C, Brinkman S, Wade T. A randomised controlled evaluation of a secondary school mindfulness program for early adolescents: do we have the recipe right yet? *Behav Res Ther*. 2017;99:37–46. doi:10.1016/j.brat.2017.09.001
19. Carsley D, Khoury B, Heath N. Effectiveness of mindfulness interventions for mental health in schools: a comprehensive meta-analysis. *Mindfulness*. 2017. doi:10.1007/s12671-017-0839-2
20. Brown KW, Ryan RM. The benefits of being present: mindfulness and its role in psychological well-being. *J Pers Soc Psychol*. 2003;84:822–848. doi:10.1037/0022-3514.84.4.822
21. Lustyk MK, Chawla N, Nolan RS, Marlatt GA. Mindfulness meditation research: issues of participant screening, safety procedures, and researcher training. *Adv Mind Body Med*. 2009;24:20–30.
22. Wilson BM, Mickes L, Stolarz-Fantino S, Evrard M, Fantino E. Increased false-memory susceptibility after mindfulness meditation. *Psychol Sci*. 2015;26(10):1567–1573. doi:10.1177/0956797615593705
23. Mettler J, Khoury B, Zito S, Sadowski I, Heath NL. Mindfulness-based programs and school adjustment: a systematic review and meta-analysis. *J Sch Psychol*. 2023;97:43–62. doi:10.1016/j.jsp.2022.10.007
24. Polizzi C, Gautam A, Lynn SJ. Trait mindfulness: a multifaceted evaluation. *Imagin Cogn Pers*. 2018;38(2):106–138.
25. Farrar S, Tapper K. The effect of mindfulness on rational thinking. *Appetite*. 2018;123:468. doi:10.1016/j.appet.2017.11.079
26. Frederick S. Cognitive reflection and decision making. *J Econ Perspect*. 2005;19:25–42. doi:10.1257/089533005775196732
27. Harnishfeger KK, Bjorklund DF. A developmental perspective on individual differences in inhibition. *Learn Individ Differ*. 1994;3:331–355. doi:10.1016/1041-6080(94)90021-3
28. Gómez-Veiga I, Vila Chaves JO, Duque G, Garcia Madruga JA. A new look to a classic issue: reasoning and academic achievement at secondary school. *Front Psychol*. 2018;9:400. doi:10.3389/fpsyg.2018.00400
29. Gómez-Chacón IM, Garcíá-Madruga JA, Vila JO, Elosúa MR, Rodríguez R. The dual processes hypothesis in mathematics performance: beliefs, cognitive reflection, working memory and reasoning. *Learn Individ Differ*. 2014;29:67–73. doi:10.1016/j.lindif.2013.10.001
30. Cokely ET, Kelley CM. Cognitive abilities and superior decision making under risk: a protocol analysis and process model evaluation. *Judgm Decis Mak*. 2009;4:20–33. doi:10.1017/S193029750000067X
31. Szaszi B, Szollosi A, Palfi B, Aczel B. The cognitive reflection test revisited: exploring the ways individuals solve the test. *Think Reason*. 2017;23(3):207–234. doi:10.1080/13546783.2017.1292954
32. Campitelli G, Labollita M. Correlations of cognitive reflection with judgments and choices. *Judgm Decis Mak*. 2010;5(3):182–191. doi:10.1017/S1930297500001066
33. Toplak ME, West RF, Stanovich KE. The Cognitive Reflection Test as a predictor of performance on heuristics-and-biases tasks. *Mem Cogn*. 2011;39:1275–1289. doi:10.3758/s13421-011-0104-1
34. Wimmer L, Bellingrath S, von Stockhausen L. Cognitive effects of a mindfulness training with fifth graders. 19th Conference of the European Society for Cognitive Psychology. Paphos, Cyprus; 2015.
35. Howell AJ, Buro K. Relations among mindfulness, achievement-related self-regulation, and achievement emotions. *J Happiness Stud*. 2011;12(6):1007–1022. doi:10.1007/s10902-010-9241-7
36. Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. *Assessment*. 2006;13(1):27–45. doi:10.1177/1073191105283504
37. Yeigh T. Cognitive inhibition and cognitive load: a moderation hypothesis. *Internat J Cross*. 2014;5(3):1744. doi:10.20533/ijcdse.2042.6364.2014.0243
38. Song KY, Muschert GW. Opening the contemplative mind in the sociology classroom. *Humanity Soc*. 2014;38(3):314–338. doi:10.1177/0160597614537794

39. Teodorczuk K, Guse T, Du Plessis G. *Mindfulness and Academic Achievement in South African University Students* [Doctoral dissertation, Doctoral dissertation]. Johannesburg University; 2013.
40. Shao R, Skarlicki DP. The role of mindfulness in predicting individual performance. *Can J Behav Sci*. 2009;41(4):195–201. doi:10.1037/a0015166
41. Beauchemin J, Hutchins T, Patterson F. Mindfulness meditation may lessen anxiety, promote social skills and improve academic performance among adolescents with learning disabilities. *Complement Health Pract Rev*. 2008;13(1):34–45. doi:10.1177/1533210107311624
42. Firth AM, Lugo RG, Sütterlin S. Using sport psychological skills training (PST) to improve academic achievement in student-athletes. *Educ Sci*. 2019;9(2):89. doi:10.3390/educsci9020089
43. Cetin B. Academic motivation and self-regulated learning in predicting academic achievement in college. *J Int Educ Res*. 2015;11(2):95–106.
44. Duckworth AL, Carlson SM. Self-regulation and school success. *Self Regulat Auton*. 2013;40(1):208–230.
45. Duckworth AL, Seligman ME. Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychol Sci*. 2005;16(12):939–944. doi:10.1111/j.1467-9280.2005.01641.x
46. Zimmerman BJ. Developing Self-Fulfilling Cycles of Academic Regulation: an Analysis of Exemplary Instructional Models. In: Zimmerman BJ, Schunk DH, editors. *Self-Regulated Learning. From Teaching to Self-Reflective Practice*. New York: Guildford Press; 1998.
47. Ostafin BD, Robinson MD, Meier BP. *Handbook of Mindfulness and Self-Regulation*. New York: Springer; 2015.
48. Ortner CN, Kilner SJ, Zelazo PD. Mindfulness meditation and reduced emotional interference on a cognitive task. *Motiv Emot*. 2007;31(4):271–283. doi:10.1007/s11031-007-9076-7
49. Chiesa A, Serretti A, Jakobsen JC. Mindfulness: top–down or bottom–up emotion regulation strategy? *Clin Psychol Rev*. 2013;33(1):82–96. doi:10.1016/j.cpr.2012.10.006
50. Quirk GJ, Beer JS. Prefrontal involvement in the regulation of emotion: convergence of rat and human studies. *Curr Opin Neurobiol*. 2006;16(6):723–727. doi:10.1016/j.conb.2006.07.004
51. Chambers R, Gullone E, Allen NB. Mindful emotion regulation: an integrative review. *Clin Psychol Rev*. 2009;29(6):560–572. doi:10.1016/j.cpr.2009.06.005
52. Brockman R, Ciarrochi J, Parker P, Kashdan T. Emotion regulation strategies in daily life: mindfulness, cognitive reappraisal and emotion suppression. *Cogn Behav Ther*. 2017;46(2):91–113. doi:10.1080/16506073.2016.1218926
53. Goldin PR, Gross JJ. Effects of mindfulness-based stress reduction (MBSR) on emotion regulation in social anxiety disorder. *Emotion*. 2010;10(1):83. doi:10.1037/a0018441
54. Stanovich KE, West RF. Individual differences in reasoning: implications for the rationality debate? *Behav Brain Sci*. 2000;23(5):645–665. doi:10.1017/S0140525X00003435
55. Stanovich KE, West RF. On the relative Independence of thinking biases and cognitive ability. *Pers Proc Individ Differ*. 2008;94(4):672–695.
56. Brown KW, West AM, Loverich TM, Biegel GM. Assessing adolescent mindfulness: validation of an adapted mindful attention awareness scale in adolescent normative and psychiatric populations. *Psychol Assess*. 2011;23(4):1023. doi:10.1037/a0021338
57. Lau MA, Bishop SR, Segal ZV, et al. The Toronto mindfulness scale: development and validation. *J Clin Psychol*. 2006;62(12):1445–1467. doi:10.1002/jclp.20326
58. Zuckerman M. The distinction between trait and state scales is not arbitrary. *J Pers Soc Psychol*. 1983;44:1083–1086. doi:10.1037/0022-3514.44.5.1083
59. Jordan CH, Wang W, Donatoni L, Meier BP. Mindful eating: trait and state mindfulness predict healthier eating behavior. *Pers Individ Dif*. 2014;68:107–111. doi:10.1016/j.paid.2014.04.013
60. Keye MD, Pidgeon AM. Investigation of the relationship between resilience, mindfulness, and academic self-efficacy. *Open J Soc Sci*. 2013;1(06):1. doi:10.4236/jss.2013.16001
61. DeCaro MS, Thomas RD, Albert NB, Beilock SL. Choking under pressure: multiple routes to skill failure. *J Exp Psychol Gen*. 2011;140(3):390. doi:10.1037/a0023466
62. Kiken LG, Garland EL, Bluth K, Palsson OS, Gaylord SA. From a state to a trait: trajectories of state mindfulness in meditation during intervention predict changes in trait mindfulness. *Pers Individ Dif*. 2015;81:41–46. doi:10.1016/j.paid.2014.12.044