IMPACT OF MEDITATION ON CRITICAL THINKING: A COMPARATIVE DESCRIPTIVE ANALYSIS OF THE CORRELATION OF MEDITATION PRACTICES AND CRITICAL THINKING

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ABSTRACT
Critical thinking is an essential skill and many authors have decried the lack of critical thinking development among students and adults. Many strategies have been implemented to ameliorate the problem, but no consensus has been reached on the most effective methods. Because meditation enhances the ability to focus inward on ones' experiences and thoughts, and a key component of critical thinking is the ability to identify and evaluate one's own thinking, this study proceeded from the hypotheses that the longevity, frequency, and type of meditation may be correlated with the ability to think critically. The California Critical Thinking Skills Test - Numeracy (CCTST-N) and a survey with questions about demographics and type, longevity, and frequency of meditation were administered to 49 college students and faculty at several post-secondary institutions in the US. A significant positive correlation was found between frequency of meditation, for those who practice focused attention types of meditation, and critical thinking skills. The results may be used as the basis for further research, and as partial justification for encouraging meditation practices for those who wish to improve their critical thinking.
Keywords: meditation, critical thinking, focused attention, open monitoring

Introduction

Clear communication, the ability to solve complex problems and think critically are what 95% of employers are looking for in recent college graduates (Hart, 2013); yet poor critical thinking (CT) skills, a problem identified among students at all levels more two decades ago (Terenzini, Springer, Pascarella, & Nora, 1995), persist (Arum, 2011; Goldsmith, 2013; Kokkidou, 2013; Tsai, Chen, Chang, & Chang, 2013). Even after the end of formal education, critical thinking is important for adults in social and career pursuits (Dwyer, Hogan, and Stewart, 2014). Nijiraini (2016) noted that critical thinking is essential for continual adaptation to a rapidly changing society. Graduates, themselves, expect their universities to prepare them for work force transition, and consider curriculum re-designs that support these transitions (Cameron, Tiessen, Grantham, & Husband-Ceperkovic, 2018).

Research has focused on a variety of strategies to enhance CT skills, either directly (Arum, 2011; Kokkidou, 2013; Nelson & Crow, 2014, Tsai et al., 2013), or indirectly (Angolia & Reed, 2018). The experience gained in higher education is thought to increase CT skills, yet Arum (2011), who tracked more than 2000 students through their undergraduate degrees (2005 – 2009), found that 36% made no significant improvement in CT; Goldsmith (2013) noted that college seniors scored only 51% when measured on CT. A complementary approach is to explore methods that faculty of higher education can employ to improve their skills in CT assessment, with the ultimate goal of enabling affective change among their students (Haynes, Lisic, Goltz, Stein, & Harris, 2016).

Researchers continue to emphasize the need to increase CT (Haynes et al., 2016), both with respect to identifying issues and critically and reflectively generating solutions (Kokkidou, 2013; Tsai et al., 2013). Unresolved, however, is agreement on how to enhance CT. Meditation has been theorized as helping to increase attentional focus (Moore & Malinowski, 2009), learning effectiveness (Ching, Koo, Tsai, & Chen, 2015), and cognitive functioning (Waters, Barsky, Ridd, & Allen, 2015), elements which may lead to an improvement in CT.

Meditation has been suggested as a technique to help college students manage stress (Singh, Sharma, & Talwar, 2012), and limited evidence also indicates that meditation may contribute to CT skills, due to its ability to stimulate attentional focus (Moore & Malinowski, 2009), cognitive functioning (Waters et al., 2015), and learning effectiveness (Ching et al., 2015). Different forms of meditation, among beginners and more experienced practitioners, are documented in the literature, and Davidson and Kaszniak (2015) suggested differentiating between types of meditation is important in research. To date, few studies have examined the direct relationship between meditation and CT or compared the outcomes of different types of meditation. The aim of this study was to measure the correlation between longevity of meditation practice, frequency of meditation sessions, type of meditation conducted, and CT skills in those affiliated with higher education.

Critical Thinking in Education

Critical thinking research has a long history and extends into multiple branches. Definitions in the literature focus on myriad combinations of cognitive skills, metacognitive skills, and dispositional qualities. The 1990 American Philosophical Association Delphi Report stated that CT is a tool of inquiry that involves "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Faccione, 1998, p. 2).

Many researchers have investigated antecedents to critical thinking. For instance, demographic characteristics seem to correlate with CT (Arslan, Gulveren, & Aydin, 2014; Howenstein, Bilodeau, Brogna, & Good, 1996; Moon, 2012). Others focused on academic approaches that may improve CT, such as the use of end-of-chapter critical thinking exercises (Cotter & Tally, 2009), rubrics to guide learning (Sanchez, Rivas, & Moral, 2015), and active-learning strategies (Nelson & Crow, 2014). These studies yielded mixed results: some improved CT while others resulted in no change or a decrease in CT expression.

Magno (2009) tested two metacognition models, in an attempt to discover a more intrinsic explanation for the development of CT skills. The results indicated that factors in both models correlated significantly to CT, where CT predicted metacognitive skills such as *planning* and *regulation of cognition* (intentional sequencing of cognitive tasks to reach an intended result). These particular metacognitive skills have also been called the *executive functioning* operation of the brain (Helber, Zook, & Immergut, 2012).

Critical Thinking Theory

Theories related to critical thinking abound. Although Elder and Paul (2010a) posited a stage theory of CT development, most theories focus on defining CT as a construct involving a number of cognitive activities. Some definitions are offered by acknowledged experts in the field (for example, Elder & Paul, 2010b; Ennis, 2011) others are elicited through research studies (for example, Geng, 2014; Moore, 2013).

Because of the rigor involved in its development and the thoroughness of its explication, the definition for CT developed by the American Philosophical Association (APA) served as the framework for this investigation. The APA definition evolved from a 13-month long Delphi study encompassing 46 participants from the fields of philosophy, education, social sciences, and physical sciences (Faccione, 1998). The final report emphasized that critical thinking must be considered as a combination of abilities and personal disposition; the description of abilities is the foundation for this study.

The findings of the panel made clear that CT is not specific subject matter expertise as much as expertise in methods of thinking about subject matter (Faccione, 1998). Six cognitive skill areas were identified as comprising CT. Brief descriptions of each skill area (Faccione) are summarized below:

Interpretation: the ability to categorize, describe significance of, and clarify meaning.
Analysis: the ability to define, compare, and contrast ideas, to divide issues into component parts, and recognize and analyze arguments.
Evaluation: the ability to assess claims, judge the logic of arguments, and determine fallacious inferences.
Inference: the ability to recognize premises that require support and where to find the support, to create alternative choices or hypotheses for responding to a question or problem, and to form inferences based on appropriate types of reasoning.
Explanation: the ability to accurately express the results of one's reasoning process, justify the reasoning process, and present the resulting reasons supporting the claim.
Self-regulation: the ability to examine and assess one's own reasoning, recognize how emotions, prejudices, values, and interests may limit rationality and fair-mindedness, and implement strategies to correct deficiencies in thinking.

Meditation Practice

Meditation practices are varied. Lutz, Slagter, Dunne, & Davidson (2008) identified two primary types of meditation practice: focused attention (FA) meditation and open monitoring (OM). The FA meditation involves paying close attention to a specific object or process, such as breathing, a mantra, or a vision (Lutz et al., 2009). Transcendental Meditation, a well-known practice, is a form of FA (Canter & Ernst, 2003). Lutz et al. (2008) noted that FA requires the cognitive activities of conflict monitoring, selective attention, and sustaining attention, and should result in improvement in these areas of brain activity.

In OM, the practitioner is aware of ongoing experiences without emotional or cognitive attachment to the experiences – sustaining awareness without selecting a specific focus (Lutz et al., 2008). In contrast to FA, OM requires the cognitive efforts of "monitoring, vigilance, and disengaging attention from stimuli" (p. 3). OM is the foundation for mindfulness practices and should lead to sharper awareness of body and environment and less mental distress. Helber et al. (2012) and Lutz et al. suggested these types are not completely separate but occupy positions on a continuum – OM usually begins with FA.

Lutz et al. noted a third type of meditation, a focus on experiencing and expressing compassion and good will toward others. While meditation practices may have similarities, Lutz et al. (2009) argued that not differentiating between types of meditation practice was similar to assuming that all sports are the same. While some researchers studied focused attention meditation (see Canter & Ernst, 2003; MacLean, Ferrer, Aichele, Bridwell, Zanesco, et al., 2010), and others studied open monitoring meditation like mindfulness (see Lakey, Campbell, Brown, & Goodie, 2007; Moore & Malinowski, 2009), studies were not found in which researchers compared the effects of different types of meditation.

Meditation and Academic Outcomes

The literature on the effects of meditation on academic performance is diverse and almost unanimously positive, though researchers have not always specifically defined the types of meditation practices studied. Ho-Hoi, Koo, Tsung-Huang, and Chiu-Yuan (2015) and Moore and Malinowski (2009) reported improvement in attention resulting from the practice of meditation. The practice of meditation has improved general knowledge question accuracy (Brown, Ryan, & Creswell, 2014; Lakey et al., 2007), improved overall academic performance (Nidich et al., 2011), and learning effectiveness (Ho-Hoi et al., 2015). A recent study conducted among medical students found a mindfulness-based intervention improved critical thinking skills of new learning resulting from reflection (analysis) and judgement (evaluation) (Patil, Thakare, Ranade & Rawekar, 2020). Researchers have also focused on relationships between meditation practice and cognitive/emotional constructs. Brown et al. (2014) reported lower levels of anxiety as a result of meditation; Lakey et al. (2007) reported appropriate levels of confidence in thinking ability.

Meditation and Critical Thinking

Some research results indicate a potential relationship between meditation and CT skills (for example see Noone, Bunting, and Hogan, 2016). For instance, Helber et al. (2012) noted that meditation improves executive functioning, described as "the complex cognitive abilities necessary for planning, self-monitoring, goal setting, and strategic behavior" (p. 351). These abilities seem aligned with the metacognitive skills identified by Magno (2009) - *planning* and *regulation of cognition* - that positively predicted CT.

Results of other studies also indicate a potential relationship between meditation and CT. Moore and Malinowski's (2009) finding that meditation enhances cognitive flexibility seems to align with the abilities of "interpretation, analysis, evaluation, and inference" described in the APA Delphi Report (Faccione, 1998) defining critical thinking. Leland (2015) observed that because mindfulness, a type of meditation, requires inward attention to one's experiences, the practice may also enhance critical thinking, which requires the internal questioning of logic and beliefs. An individual's confidence levels that result from mindfulness (Lakey et al., 2007) may also result in students trusting their own critical thinking efforts.

Lutz et al. (2008) encouraged researchers to investigate which specific meditation practices are most suitable for developing specific cognitive and affective strengths. However, no research has been found that explicitly tests whether a relationship exists between meditation and critical thinking skill, or if a relationship is mediated by the duration and frequency of meditation or the type of meditation practice.

Methods

This is a cross-sectional study, examining meditation practices among individuals at institutions of higher education. Ethics approval was obtained prior to data collection. Data were collected via self-administered surveys. A quantitative correlational approach was chosen to answer these research questions:

RQ1: Controlling for type of meditation practice, what relationship, if any, exists between longevity of meditation practice and CT as measured by each dimension of the California Critical Thinking Skills Test – Numeracy (CCTST-N) instrument?
H1 – Controlling for type of meditation practice, a statistically significant relationship exists between longevity of meditation practice and student CT as measured by each dimension of the CCTST-N instrument.
RQ2: Controlling for type of meditation practice, what relationship, if any, exists between frequency of meditation practice and CT as measured by the CCTST-N instrument?
H2 – Controlling for type of meditation practice, a statistically significant relationship exists between frequency of meditation practice and student CT as measured by each dimension of the CCTST-N instrument.
The purpose of this quantitative correlational study was to investigate the extent to which longevity and frequency of four primary types of meditation practice (focused attention meditation [FA], open monitoring meditation [OM], a combination of both, or something else) contribute to CT skills among attendees at higher education institutions. The outcome variable, critical thinking skills, was measured by the overall and 8-frame CCTST-N scores. The predictor variables, captured as part of a brief demographic survey, were the longevity of meditation practice (measured in years), the frequency of practice (measured in days per week), and the type of meditation practiced (FA, OM, a combination, or something else).

Sample
The decision was made to include both students and faculty to ensure sufficient variety of experiences with meditation and because critical thinking is an important characteristic for both groups. The sample was recruited through postsecondary institutions with which the researchers were associated. Students were recruited from programs that were delivered in a hybrid format, which included both distance learning and face-to-face. One was a two-year college with an emphasis on meditation and healing arts. Another was a large private university, and the third was a large private online university. Institutional Research Board approval was obtained from each institution. Given a Type I error rate (α) of .05, power of .80, and a medium R^2 effect size of .15, the minimum sample size recommended by GPower software was $n = 77$.

Procedure
Institutional Review Board (IRB) approval was obtained prior to commencement of the study. Study sites, forms, and procedures were approved by the IRB of the lead author's institution. Participants were recruited through a combination of emails, posted hard copy notices, and website announcements describing the study. The link to the online site for the survey was provided to those interested. The surveys contained items about participant demographic and meditation habits. Participants were required to electronically acknowledge and agree to an informed consent document before being transported to the survey questions. After completing the demographic survey, participants clicked on a link to the CCTST-N instrument, hosted by Insight Assessment (2016), the distributor for the instrument.

Instruments
The CT assessment tool is the online *California Critical Thinking Skills Test - Numeracy* (CCTST-N) that employs scales aligned with the APA definition of CT. The instrument yields eight individual scale scores—analysis, interpretation, inference, evaluation, explanation, induction, deduction, and numeracy, and an overall CT score. Items and scales have been validated and replicated in both undergraduate and graduate student populations (Insight Assessment, 2016).

Construct validity was tested by comparing CCTST-N scores to scores on the Graduate Record Exam (GRE); high correlations were found (GRE Total Score: Pearson r = .719, p<.001; GRE Analytic r = .708, p<.001; GRE Verbal r = .716, p<.001; GRE Quantitative, r = .582, p<.001). Predictive validity is supported by a number of independent research studies, including doctoral dissertations, investigating critical thinking in education, training, and leadership (Insight Assessment, 2016).

The Kuder-Richardson statistic measured the internal consistency of the CCTST-N. The overall scale score was at least .70 in validation studies and subsequent large population samples. Individual item factor loadings ranged from .300 to .770. KR statistics for the eight individual scales were not reported. Test-retest reliability scores meet or exceed .80 when the retest occurred at least two weeks after the pretest.

Results
Table 1 displays frequencies for each combination of type of meditation, frequency of practice, duration of practice, and accompanying mean CCTSI-N score. Descriptive statistics revealed eight people did not meditate at all. Of the eight people practicing *focused attention* meditation, four reported practicing no more than three times per week for no more than two years. One person reported three or more years of practicing up to three

times per week. Three people practiced FA meditation four times per week or more - two had been meditating up to two years, and one person had practiced for three or more years.

As shown in Table 1, one person practiced *open monitoring* meditation, up to three times/week for three or more years. A larger number - 27 - reported combining OM with FA meditation. Fourteen people practiced no more than three times per week; nine of these practiced for up to two years, five practiced three or more years. For the 13 people meditating four times/week or more, four had been meditating up to two years, and nine had meditated for three or more years.

Table 1 Mean CCTS-N Scores, stratified by Meditation Type, Frequency of Practice, and Length of time Practicing

Type	Frequency	Length	Mean	Std. Deviation	n
No meditation			74.75	6.71	8
Focused Attention (FA)	<= 3x/Week	<=2 years	65.25	4.99	4
		>=3 years	65.00	.	1
		Total	65.20	4.32	5
	>= 4x/Week	<=2 years	76.50	4.95	2
		>=3 years	76.00	.	1
		Total	76.33	3.51	3
Open Monitoring (OM)	<= 3x/Week	>=3 years	75.00	.	1
		Total	75.00	.	1
FA and OM	<= 3x/Week	<=2 years	73.00	3.71	9
		>=3 years	76.00	8.72	5
		Total	74.07	5.84	14
	>= 4x/Week	<=2 years	68.75	7.23	4
		>=3 years	71.33	4.56	9
		Total	70.54	5.33	13
Other Type	<= 3x/Week	<=2 years	68.00	.	1
		>=3 years	78.50	.71	2
		Total	75.00	6.08	3
	>= 4x/Week	>=3 years	72.50	4.95	2
		Total	72.50	4.95	2
Total	<= 3x/Week	<=2 years	72.00	6.05	22
		>=3 years	75.22	7.36	9
		Total	72.94	6.50	31
	>= 4x/Week	<=2 years	71.33	7.23	6
		>=3 years	71.92	4.38	12
		Total	71.72	5.28	18
	Total	<=2 years	71.86	6.18	28
		>=3 years	73.33	5.92	21
		Total	72.49	6.05	49

Outliers and Tests for Normality and Homogeneity

There were no outliers in the data, as assessed by inspection of a series of boxplots. Overall critical thinking scores were normally distributed ($p > .05$) except for one group (combination of FA and OM, meditating 4 times a week or more, and meditating for up to two years, $p=.021$), as assessed by Shapiro-Wilk's test of normality.

The decision was to run the ANOVA because it is considered to be fairly robust to deviations from normality. Additional testing revealed homogeneity of variances for overall scores for all group combinations of type, frequency and length, as assessed by Levene's test for equality of variances, $p = .078$ as displayed in Table 2.

Table 2 Levene's test for Equality of Variances for total CCTSI-N Scores

F	df1	Df2	Sig
1.975	8	36	0.078

ANOVA Tests

The primary goal of running a three-way ANOVA is to determine whether there is a three-way interaction between the three independent variables: type, frequency and length of meditation. Answering the research questions required testing if the simple two-way frequency and length interaction differed between the different types of meditation. The three-way ANOVA revealed no statistically significant three-way interaction between type, frequency and length (F [1, 36] = .000, p = 0.988) but a two-way interaction was found between type and frequency (F [1,36] = 4.367, p = 0.020), so we proceeded to run simple main effects to determine the impacting variable.

The simple main effect of frequency on overall score mean for FA meditation was statistically significant (F [1, 36] = 5.509, p = 0.025), but not for the other types (p > 0.05). Additionally, none of the other types of meditation had any interaction with any of the frequencies.

Bonferroni Adjustments

All pairwise comparisons were made for types with a Bonferroni adjustment. Overall score was 76.250 for the group who practiced 4 times per week or more and 65.125 for the group who practiced 3 times per week or less, a statistically significant difference of 11.25 (95% CI, 1.512 to 20.738, p = 0.025). The overall score was significantly lower for the group who practiced FA meditation three times per week or less compared to the group who practiced FA meditation four times per week or more. There were no significant results for any other combination of type and frequency of meditation. See Tables 3, 4, and 5.

Table 3 Overall Estimated Marginal Means, comparing type of Meditation Practice by Frequency of Practice

Meditation Type	Frequency	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Unspecified	<= 3x/Week	74.75	2.021	70.65	78.85
	>= 4x/Week	.[a]	.	.	.
FA	<= 3x/Week	65.13	3.196	58.64	71.61
	>= 4x/Week	76.25	3.501	69.15	83.35
OM	<= 3x/Week	75.00	5.717	63.41	86.59
	>= 4x/Week	.[a]	.	.	.
FA and OM	<= 3x/Week	74.50	1.594	71.27	77.73
	>= 4x/Week	70.04	1.718	66.56	73.53
Other	<= 3x/Week	73.25	3.501	66.15	80.35
	>= 4x/Week	72.50	4.042	64.30	80.70

[a]This combination of factors is not observed, thus the corresponding population marginal mean is not estimable.

Table 4 Overall Univariate Tests

Meditation Type	Sum of Squares		df	Mean Square	F	Sig.
Unspecified	Contrast	.00	0	.	.	.
	Error	1176.50	36	32.68		
FA	Contrast	180.02	1	180.02	5.509	0.025
	Error	1176.50	36	32.68		
OM	Contrast	.00	0	.	.	.
	Error	1176.50	36	32.68		
FA and OM	Contrast	118.28	1	118.28	3.619	0.065
	Error	1176.50	36	32.68		
Other	Contrast	.64	1	.64	0.020	0.889
	Error	1176.50	36	32.68		

Table 5 Overall Pairwise Comparisons

Meditation Type	(I) Frequency	(J) Frequency	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Unspecified	<= 3x/Week	>= 4x/Week	.[a]	.	.	.	.
	>= 4x/Week	<= 3x/Week	.[b]	.	.	.	.
FA	<= 3x/Week	>= 4x/Week	-11.13*	4.74	.025	-20.74	-1.51
	>= 4x/Week	<= 3x/Week	11.13*	4.74	.025	1.51	20.74
OM	<= 3x/Week	>= 4x/Week	.[a]	.	.	.	.
	>= 4x/Week	<= 3x/Week	.[b]	.	.	.	.
FA and OM	<= 3x/Week	>= 4x/Week	4.46	2.34	.065	-.30	9.21
	>= 4x/Week	<= 3x/Week	-4.46	2.34	.065	-9.21	.30
Other	<= 3x/Week	>= 4x/Week	.75	5.35	.889	-10.10	11.60
	>= 4x/Week	<= 3x/Week	-.75	5.35	.889	-11.60	10.10

Discussion/Conclusion

Poor CT skills among 21st century college students have been criticized (Terenzini et al., 1995), and critical thinking is necessary for graduates as they move into adulthood and pursue social and career goals (Cameron et al., 2018; Dwyer et al., 2014). Activities or interventions that improve academic performance are accepted as improving critical thinking for students of higher education (Rahay & Sapriati, 2018).

Many CT studies involved teaching strategies; less attention has been given to alternative ways to develop the brain's ability to think clearly and critically. Independent research on critical thinking and meditation has yielded results that, when considered together, indicated a connection may exist between meditation practices and the ability to think critically. The strength of the study lies in the fact that, to date, this may be the first examination of critical thinking and meditation that evaluates the influence of the length of time and frequency of meditation practice for several different types of meditation. The results of the current study indicate one type of meditation – *focused attention* - when practiced four or more times each week, corresponds with significantly higher critical thinking scores.

Type and Frequency of Meditation

This study may expand knowledge of demonstrated rather than just theoretical benefits of meditation, leading to differentiated understandings of the relative benefits of different types of meditation for critical thinking. Research focusing on the relationship between mindfulness, or *open monitoring* meditation, and CT has indicated mixed results. For instance, Noone et al. (2015) found that the *observing* aspect of mindfulness, or awareness of the present moment, correlated positively to CT scores, but the *non-reactivity* aspect, or monitoring one's experiences without reacting to them, correlated negatively with CT score. In a systematic review of 23 studies of mindfulness, Chiesa, Calati, and Serretti (2011) also reported mixed results pertaining to the relationship between mindfulness training and various cognitive abilities associated with CT. The current study confirmed some of the previous results indicating open monitoring meditation is not associated with increased critical thinking skills.

Studies involving focused attention meditation such as transcendental meditation (TM) reported similar mixed results. A systematic review of 10 studies measuring the influence of TM on cognitive functions found four that indicated a positive relationship, but due to subject selection and control procedures, the positive result was considered the result of an expectation effect. Nidich et al. (2011) found a significant difference in English and Math achievement among a group of middle school students practicing TM twice daily for three months, compared to a control group. None of the studies measured critical thinking. The results of the current study represent new information about a correlation between critical thinking and focused attention meditation, suggesting that training in focused attention meditation may be beneficial for college students and others interested in improving critical thinking skills.

The frequency of practice may be a determining factor. Open monitoring meditation such as mindfulness is a state of being, usually measured through self-report, more than a practice that occurs in discrete sessions. Transcendental meditation involves twice daily practice or *sitting*. In the current study, significant effects were found only for those who practiced focused attention meditation four times a week or more. Based on this

finding, interventions with those seeking to increase CT skills may only be successful if the meditation practice occurs frequently, at least four times a week. Our results may confirm Davidson and Kaszniak's (2015) recommendation that researchers avoid mixed-practice samples.

Limitations

The authors also recognize several limitations with this study. First, the correlational design limits the ability for any causal relationship to be inferred. Second, because of the relatively small study sample size, it was not possible to run higher order statistics, including structured equation modeling, to identify study outcome mediators or moderators. Third, the study sample was small, relative to heterogeneity of the sample, i.e. the sample included students of higher education as well as graduates and instructors. Fourth, the questions of length and frequency of meditation practice did not account for longitudinal changes in practice. Someone practicing for six years, for example, may have practiced more or less frequently in recent times, compared to when they first initiated the practice. Finally, the study relied on subjects' personal recollections on the length and frequency of their practice.

Despite these limitations, the findings of the study add to the body of knowledge regarding the relationship between the practice of meditation and critical thinking skills. Specifically, the findings of the study add to the body of knowledge regarding the relationship between type of meditation practice, and frequency and length of meditation practice. The relatively small sample size and nature of the sample indicate that additional studies would be beneficial.

Future Research

The results clearly indicated the opportunity for future research. For instance, a study using a larger or more homogenous sample may provide more rigorous results. Switching to a quasi-experimental design would allow measurement of any differences between people who do not meditate and people who begin regular practice of focused attention meditation. In general, researchers may want to isolate or differentiate the type of meditation participants engage in.

Conclusion

In this study, the authors examined the relationship between longevity, frequency, and type of meditation and the ability to think critically. A total of 49 individuals (students, graduates, and faculty) affiliated with US-based institutions of higher education completed the California Critical Thinking Skills Test - Numeracy (CCTST-N) and a questionnaire that captured demographic information, as well as type, longevity, and frequency of meditation practice. A statistically significant and positive correlation was found between frequency of meditation, for those who practice focused attention types of meditation, and critical thinking skills. Despite the noted study limitations, the results contribute significantly to the literature examining the relationship between meditation and critical thinking. Specifically, the findings may be used as the basis for further research, and as partial justification for encouraging meditation practices for those looking to improve their critical thinking skills.

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Appendix A
Predictor Variable Questions added to CCTST-N

1. How frequently do you engage in some form of meditation?
a. I do not currently meditate.
b. Less than once per week.
c. One day per week.
d. 2-3 days per week.
e. 4-5 days per week.
f. 6-7 days per week.
g. More than once each day.
2. How long have you engaged in some form of meditation?
a. I have never meditated.
b. Less than 1 year.
c. 1-2 years.
d. 3-4 years.
e. 5-6 years.
f. 7-8 years.
g. 9-10 years.
h. Longer than 10 years.
3. Which of the following forms of meditation do you most frequently engage in?
a. I do not meditate.

b. Focused attention meditation (FA) - paying close attention to a specific object or process, such as breathing, a mantra, or a vision (transcendental meditation is one example)
c. Open monitoring meditation (OM) - noticing ongoing experiences without emotional or cognitive attachment to the experiences (mindfulness practices are one example)
d. A combination of FA and OM meditation
e. Some other form of meditation

