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Mindfulness, Sustained Attention and Post-Traumatic Stress in Tsunami Survivors

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ABSTRACT

Mindfulness involves various attention skills, including the ability to sustain and focus attention. We investigated the association between trait mindfulness and errors of omission and commission in a sustained attention task in individuals who had been exposed to the trauma of a natural disaster. A positive association between mindfulness and sustained attention was hypothesized. A disaster-exposed group (n=25) consisting of Norwegian tourists who survived the 2004 Southeast Asian tsunami in a location with high mortality rates was recruited. A control group (n=24) matched for gender, age and educational level was included in the study. Trait mindfulness and sustained attention were measured with the Five-Facet Mindfulness Questionnaire (FFMQ) and the Conner's Continuous Performance Test (CPT II) respectively. In the disaster-exposed group but not in the control group, there was a significant negative association between mindfulness and number of commission errors that was observed with linear regression after adjustment for gender, age, years of education, depression, anxiety, intelligence quotient (IQ), and amount of post-traumatic stress symptoms. To examine the associations between the five factors of mindfulness: observing, describing, acting with awareness, non-judging and non-reacting, and the number of CPT II omission and commission errors, linear regressions with adjustment for gender, age and years of education were applied. There was a significant negative association between number of commission errors and the describing factor of mindfulness in the disaster-exposed group, but not in the control group. There was a strong negative association between the factor of non-reacting and number of omission errors in the control group, and a weaker but still significant negative association between the factor of non-judging and number of omission errors in the control group. There was also a strong positive association between number of commission errors and the observing factor of mindfulness in the control group. The study shows that the association between sustained attention and mindfulness and its different aspects may be affected by disaster exposure.

KEYWORDS: Mindfulness; Attention; Disaster; Trauma; Commission errors; Post Traumatic Stress Disorder (PTSD).

ABBREVIATIONS: MBSR: Mindfulness-Based Stress Reduction; CPT II: Conner's Continuous Performance Test; FFMQ: Five-Facet Mindfulness Questionnaire; PTSD: Post Traumatic Stress Disorder; MINI: Mini International Neuropsychiatric Interview; WSAS: Work and Social Adjustment Scale; GAF-F: Global Assessment of Functioning function score; SCID-1: Structured Clinical Interview for DSM-IV; REC: Regional Ethics Committee; ADHD: Attention Deficit and Hyperactivity Disorder; BDI-II: Beck Depression Inventory II; BAI: Beck Anxiety Inventory; WASI: Wechsler Adult Short Intelligence Test; IQ: Intelligence Quotient.

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INTRODUCTION

Mindfulness embodies present moment awareness and emotional acceptance.[1] As defined by Kabat-Zinn,[2] mindfulness is paying attention in a particular way: on purpose, in the present moment, and non-judgmentally. Mindfulness can encompass different meditation practices and cognitive skills, including skills involving attention regulation and response inhibition.[3]

Mac Coon et al[4] have described mindfulness meditation as a form of attention control training by which individuals first develop the ability to direct and maintain attention towards a chosen object, requiring skills involved in monitoring the focus of attention and in detecting distraction, disengaging attention from the source of distraction, and redirecting and engaging attention to the intended object. In addition, mindfulness meditation cultivates the skill to maintain a non-judgmental, open presence to the present moment, a meta-awareness consisting of non-reactively monitoring the content of experience from moment-to-moment without being carried away by thoughts, emotions, or perceptions.[4]

The potential regulatory functions of meditative practices on attention and emotion processes have been suggested to have long-term brain and behaviour effects.[5] Attention is a cognitive system necessary for managing cognitive demands and regulating emotions. Attentional performance is positively related to levels of mindfulness and to meditation practice.[6] A review of 23 meditation studies revealed mixed effects of mindfulness training on different aspects of attention.[7] Mindfulness practice appears to positively affect attentional functioning by improving the resource allocation processes.[8] Individuals who practice meditation have been shown to have fewer commission errors than control subjects in attention tasks.[9] Commission errors indicate the number of times responses are made with no target present. A fast reaction time and high commission error rate points to difficulties with impulsivity. Omission errors indicate the number of times a target is presented, but no response is made. High omission rates indicate difficulties with paying attention to stimuli or a sluggish response.

Mindfulness-based practices involve attentional skills, including the ability to sustain and focus attention. Sustained attention has been found to be associated with meditation practice.[10,11] Three months of vipassana meditation led to reductions in trial-by-trial variability in reaction times in a sustained attention task.[10] Meditation-related improvements on sustained attention have been found on a continuous performance task.[11] In a sustained visual attention task, performance and the number of commission errors was related to self-reported mindfulness.[12] In a recent longitudinal randomized study by McCoon et al,[4] no differences in sustained attention were found between participants in a mindfulness-based stress reduction (MBSR) course compared to active controls. As seen above, studies targeting the association between mindfulness and sustained attention in non-clinical populations show varied and even somewhat contradictory results. There is a need to investigate factors that might affect these results, and this is where our study makes a contribution to this unexplored scene. We assume that mindfulness capability improves sustained attention. The relation between sustained attention and trait mindfulness is probably bi-directional. Well-developed functions of sustained attention may positively contribute to mindfulness ability. In our study which is correlational, we look at the association between sustained attention measured by amount of errors of commission and omission, and total trait mindfulness and the different factors thereof.

Improvement in attentional performance is central to proposed mechanisms for stress reduction in mindfulness meditation practices.[13] Mindfulness training might protect against attentional impairments associated with stressful periods[14] and improve attention-related behavioural responses by enhancing the functioning of specific subcomponents of attention.[15,16] Persistent and intensive demands, such as those experienced during high stress, might deplete attention, resulting in cognitive failures, emotional disturbances, and impulsive behavior.[14]

The neuropsychological findings in the area of attention related to post-traumatic stress are inconsistent. Golier and Yehuda[17] have summarized the types of attention deficits that have been found in trauma survivors with post-traumatic stress disorder (PTSD) and discussed the extent to which these deficits may be risk factors for or consequences of trauma. Horner and Hamner[18] reviewed the literature on performance on neuropsychological tests among individuals with PTSD. Although 16 of 19 studies reported impairment of attention, most of these studies included PTSD patients with significant psychiatric comorbidity. Other potential confounds were medical illness, substance abuse and motivational factors. We face the "chicken-egg" dilemma of what comes first, trauma or attention deficits. Crowell et al[19] addressed methodological limitations of research in this area, concluding with that cognitive difficulties linked to PTSD may actually have been secondary to pre-existing individual differences or other clinical conditions coexisting with PTSD. Samuelson et al[20] showed that when controlling for depression and alcohol abuse, attention deficits were associated with PTSD. Koso and Hansen[21] discussed the possibility of PTSD being associated with dysfunction of a higher-level attentional resource which in turn affects other cognitive functioning such as memory and thought. Lagarde et al[22] found attentional deficits in a group with a diagnosis of acute PTSD only, and not among trauma-exposed individuals without acute PTSD or among individuals not exposed to trauma. PTSD patients have been found to be impaired relative to individuals without psychiatric diagnoses on a measure of focused attention.[23] A study by Golier et al[24] did not find attention deficits associated with PTSD on a continuous performance test. In a study by Neylan et al,[25] healthy, well-educated males with combat-related PTSD without current depression or recent alcohol/drug abuse, did not perform differently on tests of attention compared to normal comparison participants. Neuropsychological research findings in the area of trauma-exposure and attention do not answer the "chicken-

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egg" question. Post-traumatic stress in survivors of a major disaster has been linked to attentional dysfunction 2-3 years post-disaster.[26] Deficiencies in sustained attention have been shown in veterans and in rape survivors with symptoms of post-traumatic stress.[27,28] Errors of commission during visuospatial maze learning have been found to discriminate between post-traumatic stress disorder (PTSD) and non-PTSD.[29]

Moore et al[30] suggested that in mindfulness practice, sustained attention is required to maintain focus on the breath, whereas cognitive control is required to detect mind wandering. We expand this hypothesis by reasoning that sustained attention, in addition to maintaining focus on the breath, also contributes to the detection of mind wandering and to trait mindfulness. Our rationale behind this reasoning is that we see mindfulness as a meta-cognitive function that includes attentional control and awareness of one's own attention. As we see it, mindfulness can be conceptualized as a meta-attentional process. Attentional control has been suggested to be a buffering mechanism against prolonged attentional engagement with threat-related stimuli among those with high levels of post-traumatic stress symptoms.[31]

Whether there is an association between mindfulness and sustained attention in disaster survivors with increased levels of post-traumatic stress symptoms is of interest. To the best of our knowledge, no studies have investigated the association between mindfulness and sustained attention in disaster survivors or in any population with symptoms of post-traumatic stress. Our subjects are non-clinical but disaster-exposed. We hypothesized that trait mindfulness, the capacity to deliberately attend to present experience without judgment, involves sustained attention, and we aimed to investigate the association between trait mindfulness and errors of omission and commission in disaster survivors with a sustained attention task. We hypothesized that there would be a positive association between mindfulness and sustained attention, and we expected negative associations between mindfulness and omission or commission errors.

Participants

The participants for our study were recruited from an earlier interview study of Norwegian disaster survivors who experienced the 2004 Southasian tsunami in Khao Lak, Thailand.[32] Norwegian tourists in Khao Lak were severely affected by the tsunami,[33] and of the 84 Norwegians who perished in the disaster, 68 were in Khao Lak. The Norwegian police registry reported that 82 Norwegian adults survived in Khao Lak. After submitting an application to the Norwegian Data Inspectorate, names were made available for the earlier interview study. Persons over the age of 18 years at the time of the disaster were invited to participate in the study and 63 agreed to being interviewed in person 2.5 years after the disaster. The examination included the Mini International Neuropsychiatric Interview (MINI), the PTSD module of the Structured Clinical Interview for DSM-IV (SCID-1) Axis I disorders, the Work and Social Adjustment Scale (WSAS), the Global Assessment of Functioning function score (GAF-F), and questions covering background characteristics and disaster exposure.[32]

For this study, the identical participants were contacted over the phone to inquire whether they would be willing to participate in our study. Of these 63 individuals, 3 could not be reached, 2 had died, and 25 agreed to participate. Of these 25 disaster survivors, 13 had been caught by the waves, 6 had been touched or chased by the waves, and 6 reported no direct exposure to the waves. Most of the participants, including all the participants who had not been directly exposed to the waves, reported strong witness experiences, including observing seriously injured individuals, corpses, or abandoned children. Five participants reported that a close family member had perished in the tsunami; three participants had lost their husbands; and three participants had lost one or more of their children. Exclusion criteria in our study included a serious medical or neurological illness and non-functional Norwegian language skills. The same exclusion criteria applied for the disaster-exposed group and the control group.

A control group consisting of 24 individuals was recruited *via* written advertisements seeking individuals interested in participating in the study. The recruitment of the control group was conducted such that there were no significant differences between the disaster-exposed and the control group with respect to gender, age, and years of education. *T*-tests did not show any significant differences between the two groups in in relation to depression, anxiety and IQ. The disaster-exposed group had significantly higher amount of post-traumatic stress symptoms than the control group.

PROCEDURE

In accordance with regional and international ethical standards, written informed consent was obtained from all the participants. Information on the study and the option of withdrawing was provided verbally and in writing. The testing of all the participants was performed by the identical test administrator in a one-on-one setting. The instruments used were administered in the order of the questionnaires measuring trait mindfulness, post-traumatic stress, depression and anxiety presented first, after which sustained attention was measured followed by measuring intelligence. The study was approved by the Regional Ethics Committee (REC) and the relevant committees for patient integrity, in accordance with the 1964 Declaration of Helsinki ethical standards.

MEASURES

Conner's Continuous Performance Test (CPT II)

Conner's Continuous Performance Test (CPT II),[34] is a test that measures sustained attention. Administration and scoring of the test is computerized. Alphabet letters are displayed, and

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the respondent is asked to press the space key when any letter except the letter X appears on the screen. Pressing letter X is a commission error, and not pressing for any of the other letters is an omission error. The administration procedure requires approximately 15 minutes. The split-half reliability is .94 for omission errors and .83 for commission errors. The test-retest correlation coefficients for omission and commission errors are .84 and .65, respectively. Validity studies have shown the ability of the test to differ between non-clinical and clinical subjects in relation to attention deficit and hyperactivity disorder (ADHD).[34] In regards to the validity of the test administration, response style is discussed in the CPT II manual, in the form of a Beta statistic.[34] This statistic allows for evaluation of the speed/accuracy trade-off. Some individuals are cautious and choose not to respond very often. Conceptually, such individuals want to make sure they are correct when they give a response. The emphasis is on avoiding commission errors. Higher values of Beta reflect this response style. Other individuals respond more freely to make sure they respond to most or all targets, and they tend to be less concerned about mistakenly responding to a non-target. This response style might give less omission errors and more commission errors. Lower values of Beta are produced by this response style. In this study, there was no significant difference in Beta between the disaster-exposed group and the controls (t=1.371, p=0.177).

The Five-Facet Mindfulness Questionnaire (FFMQ)

The Five-Facet Mindfulness Questionnaire (FFMQ)[35] was used to measure trait mindfulness. The questionnaire was developed by a factor analysis of a combined pool of items from five mindfulness questionnaires. The FMMQ consists of 39 items that examine overall trait mindfulness and the mindfulness factors of observing, describing, and acting with awareness, non-judging, and non-reacting. Respondents rate each item on a five-point Liker scale that ranges from "*never or very rarely true*" to "*always or almost always true*". The observing aspect of mindfulness indicates the tendency by which an individual observes his/her inner life and surroundings. The describing aspect indicates the ability of an individual to describe his/her feelings. The acting with awareness aspect indicates the tendency of an individual to act with awareness rather than distraction. The non-judging aspect refers to the tendency of an individual to refrain from judgment of his/her experience and relate to that experience with acceptance. The non-reacting aspect indicates the tendency of an individual to avoid reacting excessively to his/her inner experience. The total score on the FFMQ is attained by adding up the scores for the five mindfulness aspects. Baer et al[35] reported adequate to good internal consistencies (ranging from .72 to .92) for each of the scales. The FFMQ has been validated in several countries,[35-40] including Norway[41] In this study Cronbach's alpha was .81 for the disaster-exposed group, .66 for the control group, and .75 for the total group.

The Impact of Event Scale-Revised Version (IES-R)

The Impact of Event Scale-Revised (IES-R)[42] version was used to measure the degree of post-traumatic stress. The scale consists of 22 items with the following three subcategories of PTSD symptoms: re-experiencing (intrusion), avoidance, and arousal. It is a self-report measure that assesses subjective distress caused by traumatic events. Items correspond directly to 14 of the 17 DSM-IV symptoms of PTSD. Respondents are asked to identify a specific stressful life event and then indicate how much they were distressed or bothered during the past seven days by each "difficulty" listed. Items are rated on a 5-point scale ranging from 0 ("not at all") to 4 ("extremely"). The IES-R yields a total score (ranging from 0 to 88). The instrument has been translated into many languages; it has internal consistency coefficients ranging from .80 to .91 and test-retest reliabilities ranging from .52 to .86.[43] In this study, Cranach's alpha was .95 for the disaster-exposed group, .96 for the control group, and .95 for the total group.

Beck Depression Inventory II (BDI-II)

Symptoms of depression were assessed with the Beck Depression Inventory-II (BDI-II).[44] The BDI-II is a 21-item self-report inventory that assesses the cardinal features of depression, each answer being scored on a scale value of 0 to 3. Higher total scores indicate more severe depressive symptoms. Scores 0-13 indicate minimal depression, scores 14-19 indicate mild depression, scores 20-28 indicate moderate depression and scores 29-63 indicate severe depression. Beck et al[44] reported a test-retest correlation of .93 in a sample of 26 out-clinic patients. Cranach's alpha in this study was .87 for the disaster-exposed group, .79 for the control group, and .83 for the total group.

Beck Anxiety Inventory (BAI)

Symptoms of anxiety were measured with the Beck Anxiety Inventory (BAI).[45] The questionnaire is designed for individuals 17 years of age or older and takes between five and ten minutes to complete. The BAI consists of 21 items that are rated on a scale from 0 to 3. Each item describes a subjective, somatic, or panic-related symptom of anxiety asking about how bothersome a symptom has been over the past month. 0 points means "not at all", 1 point means mildly "it did not bother me much", 2 points means moderately "it wasn't pleasant at times" and 3 points severely "it bothered me a lot". The BAI has a maximum score of 63, 0-9 indicating minimal anxiety, 10-16 mild anxiety, 17-29 moderate anxiety and 30-63 severe anxiety. The BAI was designed as "an inventory for measuring clinical anxiety" that minimizes the overlap between depression and anxiety scales.[46] The BAI has been shown to have high internal consistency (i.e., an alpha coefficient of .92) and a test-retest correlation of .75.[45] In this study, Cranach's alpha was .92 for the disaster-exposed group, .78 for the control group, and .90 for the total group.

Wechsler Adult Short Intelligence Test (WASI)

Intelligence was measured with the Wechsler Adult Short Intelligence Test (WASI).[47] The WASI is a standardised test that yields the three traditional verbal, performance, and full scale

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IQ scores. The verbal IQ score is assessed with two measures; specifically, the vocabulary subtest measures word knowledge, verbal concept formation, and the fund of knowledge, and the Similarities subtest measures verbal reasoning and concept formation. The performance IQ score is based on the following two different types of performance measures: the matrix reasoning test measures visual information processing and abstract reasoning skills, and the Block Design test measures the ability to analyse and synthesise abstract visual stimuli, non-verbal concept formation, visual perception and organisation, simultaneous processing, visual-motor coordination, learning, and the ability to separate figures and grounds in visual stimuli. The average reliability coefficients are .96, .96, and .98 for the verbal IQ, the performance IQ and the full scale IQ, respectively.[47] The construct validity of the WASI is supported by the intercorrelations of the WASI subtests and IQ scales, and by the results of factor analysis.[47]

DATA ANALYSIS

There was no missing data and no corrections or transformation of data. Correlations between omission and commission errors were calculated. Linear regressions with adjustments for gender, age, years of education, depression, anxiety, IQ and amount of post-traumatic stress symptoms, were applied to examine the associations between the FFMQ scores and the number of CPT II omission and commission errors. These analysis showed none of the above listed factors to be confounders for the results. To examine the associations between the five factors of mindfulness: observing, describing, acting with awareness, non-judging and non-reacting, and the number of CPT II omission and commission errors, linear regressions with adjustment for gender, age and years of education were applied. In examining the associations between the factors of mindfulness and the number of omission and commission errors, we opted for not adding the factors of depression, anxiety, IQ and amount of post-traumatic stress symptoms as adjustments, since these variables did not show significant contributions to the overall assessment of mindfulness and therefore were not considered for the sub-aspects of mindfulness.

RESULTS

Preliminary analysis did not show any significant differences between the disaster-exposed and the control group with respect to gender, age, educational level, depression, anxiety and IQ (Table 1). There was a significant difference in the amount of post-traumatic stress symptoms, measured by the IES-R, between the two groups (Table 1). Statistical analysis showed that the correlation between omission and commission errors for the total group was .573, for the disaster-exposed group .625 and for the control group .626. In the disaster-exposed group, there was no significant association between mindfulness and number of omission errors, and there was a significant association between mindfulness and number of commission errors (Table 2). This result was observed with unadjusted linear regression and after adjusting for gender, age, years of education, depression, anxiety and IQ applying hierarchical linear regression. The same result was observed when adjusting for gender, age, years of education and amount of post-traumatic stress symptoms applying hierarchical linear regression. In the control group there was neither a significant association between mindfulness and number of omission errors, nor between mindfulness and number of commission errors, unadjusted or adjusted applying hierarchical linear regression.

Linear regressions adjusted for gender, age and years of education, did not show any significant associations between the five factors of mindfulness and number of omission errors in the disaster-exposed group, but a strong negative association between the factor of non-reacting and number of omission errors in the control group, and a weaker but still significant negative association between the factor of non-judging and number of omission errors in the control group (Table 3). Linear regression adjusted for gender, age and years of education, showed a strong negative association between number of commission errors and the describing factor of mindfulness in the disaster-exposed group, but not in the control group (Table 4). In addition, linear regression adjusted for gender, age and years of education, showed a strong positive association between number of commission errors and the observing factor of mindfulness in the control group but not in the disaster-exposed group (Table 4).

DISCUSSION

To our knowledge, this study is the first to examine the association between mindfulness and sustained attention in a disaster-exposed group. As discussed in the introduction section, studies targeting the association between mindfulness and sustained attention show contradictory results. There is a need

	Disaster-exposed (n=25)	Controls (n=24)	t(df)	*p*
Age	47.96 (10.76)	40.54 (15.80)	1.928 (47)	0.060
Years of education	15.30 (1.98)	16.13 (2.42)	-1.309 (47)	0.197
BDI	4.24 (4.81)	3.46 (3.44)	0.652 (47)	0.517
BAI	5.68 (7.81)	2.88 (3.37)	1.621 (47)	0.112
WASI	114.72 (8.82)	118.33 (10.61)	-1.299 (47)	0.200
IES-R	12.88 (12.90)	4.38 (9.60)	2.609 (47)	0.012

BDI: Beck Depression Inventory; BAI: Beck Anxiety Inventory; WASI: Wechsler Abbrevated Intelligence Scale; IES-R: Impact of Event Scale-Revised.

Table 1: Participant characteristics expressed as the means (standard deviations).

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	Disaster-exposed			Controls		
	Omission errors					
	B	95% CI	*p*-value	B	95% CI	*p*-value
FFMQ unadjusted	-.062	-.166 - .042	.233	-.176	-.410 - .059	.135
FFMQ adjusted for gender, age, years of education	-.024	-.158 - .110	.718	-.232	-.506 - .042	.093
FFMQ adjusted for gender, age, years of education, depression	-.030	-.173 - .114	.670	-.267	-.551 - .018	.064
FFMQ adjusted for gender, age, years of education, depression, anxiety	-.028	-.175 - .119	.692	-.241	-.534 - .052	.101
FFMQ adjusted for gender, age, years of education, depression, anxiety, intelligence	-.036	-.191 - .120	.633	-.160	-.530 - .209	.371
FFMQ adjusted for gender, age, years of education, amount of post-traumatic stress symptoms	-.023	-.166 - .120	.744	-.232	-.516 - .051	.102
	Commission errors					
	B	95% CI	*p*-value	B	95% CI	*p*-value
FFMQ unadjusted	-.288	-.494 - -.082	.008	-.072	-.343 - .200	.589
FFMQ adjusted for gender, age, years of education,	-.258	-.485 - -.031	.028	-.090	-.426 - .245	.579
FFMQ adjusted for gender, age, years of education, depression	-.281	-.516 - -.046	.022	-.175	-.490 - .140	.258
FFMQ adjusted for gender, age, years of education, depression, anxiety	-.278	-.519 - -.038	.026	-.132	-.446 - .183	.390
FFMQ adjusted for gender, age, years of education, depression, anxiety, intelligence	-.270	-.526 - -.013	.040	-.066	-.373 - .241	.656
FFMQ adjusted for gender, age, years of education, amount of post-traumatic stress symptoms	-.240	-.475 - -.004	.046	-.095	-.436 - .246	.566

Table 2: Association between mindfulness and omission errors, and mindfulness and commission errors in a sustained attention task (CPT II) in disaster-exposed individuals (n=25) and in controls (n=24). The unadjusted results and the results after adjustment for gender, age, years of education, depression (BDI), anxiety (BAI), IQ (WASI) and after gender, age, years of education and amount of post-traumatic stress symptoms (IES-R) are shown.

	Disaster-exposed group			Controls		
	B	**95% CI**	***p*-value**	**B**	**95% CI**	***p*-value**
Observe Unadjusted Adjusted	 -.046 .060	 -.279 - .188 -.239 - .359	 .690 .680	 .317 .394	 -.091 - .726 -.032 - .819	 .121 .068
Describe Unadjusted Adjusted	 -.349 -.327	 -.607 - -.090 -.685 - .031	 .010 .072	 .135 .115	 -.337 - .606 -.429 - .659	 .560 .663
Acting with awareness Unadjusted Adjusted	 -.057 -.029	 -.322 - .207 -.312 - .253	 .658 .830	 -.345 -.373	 -.896 - .206 -.967 - .222	 .208 .205
Non-judging Unadjusted Adjusted	 .088 .045	 -.289 - .465 -.359 - .449	 .635 .819	 -.422 -.499	 -.863 - .020 -.981 - -.017	 .060 .043
Non-reacting Unadjusted Adjusted	 -.098 .085	 -.582 - .387 -.473 - .643	 .680 .754	 -.678 -.743	 -1.134 - -.223 -1.208 - -.278	 .005 .003

Table 3: Association between factors of mindfulness and omission errors in a sustained attention task (CPT II) in disaster-exposed individuals (n=25) and in controls (n=24). The unadjusted results and the results after adjustment for gender, age, and years of education, are shown.

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	Disaster-exposed group			Controls		
FFMQ factors	**B**	**95% CI**	***p*-value**	**B**	**95% CI**	***p*-value**
Observe Unadjusted Adjusted	 -.382 -.062	 -.880 - .115 -.635 - .512	 .126 .824	 .573 .660	 .169 - .977 .233 - 1.087	 .008 .004
Describe Unadjusted Adjusted	 -.956 -.826	 -1.484 - -.429 -1.462 - -.190	 .001 .014	 -.024 -.053	 -.549 - .501 -.677 - .570	 .924 .860
Acting with awareness Unadjusted Adjusted	 -.237 -.321	 -.823 - .349 -.841 - .199	 .411 .212	 -.358 -.371	 -.969 - .253 -1.057 - .315	 .237 .272
Non-judging Unadjusted Adjusted	 .135 -.235	 -.711 - .982 -1.000 - .530	 .744 .529	 -.339 -.431	 -.847 - .168 -1.010 - .148	 .179 .136
Non-reacting Unadjusted Adjusted	 -1.153 -.841	 -2.122 - - .184 -1.836 - .153	 .022 .093	 -.465 -.499	 -1.031 - .101 -1.124 - .126	 .102 .111

Table 4: Association between factors of mindfulness and commission errors in a sustained attention task (CPT II) in disaster-exposed individuals (n=25) and in controls (n=24). The unadjusted results and the results after adjustment for gender, age, and years of education, are shown.

to investigate factors that might affect these results, and this is where our study makes a contribution to this rather unexplored scene. We found a significant association between mindfulness and number of commission errors on the CPT II in our disaster-exposed group. We did not find this association in our control group matched for gender, age and level of education.

The negative association found between mindfulness and commission errors in the disaster-exposed group but not in the control group, might highlight previous findings by Teper and Inzlicht, with individuals who meditate having fewer commission errors than control subjects in a sustained attention task.[9] Additionally, our results are related to those of the Jensen et al[13] study, in which improvements in attentional performance were central to the proposed mechanisms for stress reduction in mindfulness meditation practices, and to the Leonard et al[14] study, in which mindfulness training was seen as protection against functional attentional impairments associated with periods of high stress.

The result of our study might support the hypothesis of mindfulness altering the efficiency of allocating cognitive resources, leading to improved self-regulation of attention.[15,30] Because our mindfulness measurement was in the form of self-reported mindfulness, it could be related to the Moore and Malinowski[6] study, in which attentional performance was found to be positively related to meditation practice and levels of mindfulness, with self-reported mindfulness being higher in individuals who meditate than in those who do not meditate. Although the participants in a study by Rosenberg et al[12] had not been disaster-exposed, our study supports the findings of that study, which showed that the fluctuations in sustained attention and the number of commission errors were related to self-reported mindfulness.

The hypothesis of post-traumatic stress being associated with a reduced capacity for top-down attentional control of a bottom-up or stimulus-driven effect[48] could be related to our findings. Sustained attention is an executive function conceptualized as part of top-down attentional control. Our findings of a significant negative association between number of commission errors and trait mindfulness in the disaster-exposed group, but not in the control group, can be related to the suggestion that attentional control is a buffering mechanism against prolonged attentional engagement with threat-related stimuli among those with high levels of post-traumatic stress symptoms.[31] Disaster-exposure is likely to increase alertness to threat-related stimuli and even neutral stimuli may be provocative. We see mindfulness as a meta-cognitive function that includes attentional control which may buffer against stimuli-related arousal, improving attentional performance and thus also decreasing number of commission errors.

Our finding of a strong negative association between number of commission errors and the describing factor of mindfulness in the disaster-exposed group, but not in the control group, could be conceptualized as related to narrative style of the disaster-exposed individual. There are different ways to relate to exposure to disaster, different ways to create meaningfulness or meaninglessness from such an experience and different ways to describe what happened then and what happens now. Describing involves elements of externalization, of top-down (prefrontal) activation as opposed to bottom-up (amygdala) activation. Symptoms of hyper-arousal such as hyper-vigilance refer to increased arousal and sympathetic nervous system hyperactivity that were not present before the trauma.[49] Hyper-arousal is likely to contribute to overreacting and to reacting to neutral stimuli as if they were trauma-related. This is likely to affect the narrative of the individual, in regards to the time of the disaster occurring, and also in relation to the present, making sense of and reacting to current experience. Commission errors (as opposed to omission errors) on a continuous performance task such as the CPT II, are

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intuitively more likely to occur when there is more of hyper-arousal and less of the emotionally more neutral, describing aspect of mindfulness.

The strong negative association between the non-reacting aspect of mindfulness and number of omission errors found in the control group but not in the disaster-exposed group is interesting. There was also a weaker negative association between the non-judging aspect of mindfulness and number of omission errors found in the control group but not in the disaster-exposed group. The non-judging aspect refers to the tendency of an individual to refrain from judgment of his/her experience and relate to that experience with acceptance. From a trauma theory aspect, there is less need for reacting to and judging neutral stimuli when there has not been disaster-exposure. Reacting to and judging neutral stimuli might affect allocation of cognitive resources and likelihood of making mistakes such as omission errors. This may be one of several plausible explanations of the group difference found related to association between the non-reacting and non-judging aspect of mindfulness and number of omission errors. The strong positive association between the observing aspect of mindfulness and number of commission errors found in the control group but not in the disaster-exposed group is more difficult to speculate about.

We propose that sustained attention in mindfulness contributes to breath awareness and facilitates detection of mind wandering. The association between mindfulness and sustained attention might be highly relevant in disaster survivors vulnerable to symptoms of post-traumatic stress, and the describing facet of mindfulness might be an important factor in this association. Our study shows that the association between sustained attention and mindfulness and its different aspects may be affected by disaster exposure. This study had limitations, including the small sample size as well the cross-sectional design, which precludes causal interpretations. The results of the study imply that the possible associations between different aspects of sustained attention and post-traumatic stress symptoms should be examined further. This study should be replicated in larger samples of trauma-exposed clinical and non-clinical populations. Qualitative studies, focusing on how the disaster event is described and conceptualized in the life cycle of the individual, may be useful in furthering understanding of the association between sustained attention and mindfulness in disaster-exposed individuals. The types of trauma (e.g., single, complex, extensive, or ongoing trauma) as well as the resources (e.g., coping abilities, cognitive functioning and self-regulatory strategies) and possible meditation practices of the individuals should be accounted for in future studies.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICAL STANDARDS

This study was approved by the Regional Ethics Committee (REC) and the relevant committees for patient integrity, in accordance with the 1964 Declaration of Helsinki ethical standards. All persons included in the study gave their informed consent prior to their inclusion in the study.

REFERENCES

1. Didonna F. *Clinical Handbook of Mindfulness*. New York, NY, USA: Springer, 2009.

2. Kabat-Zinn J. *Wherever you go, there you are: Mindfulness Meditation in Everyday Life*. New York, USA: Hyperion; 1994.

3. Williams JMG, Kabat-Zinn J. Mindfulness: Diverse perspectives on its meaning, origins, and multiple applications at the intersection of science and dharma. *Contemporary Buddhism*. 2011; 12(1): 1-18. doi: 10.1080/14639947.2011.564811

4. MacCoon DG, MacLean KA, Davidson RJ, Clifford D, Saron CD, Lutz A. No sustained attention differences in a longitudinal randomized trial comparing Mindfulness Based Stress Reduction versus active control. *PLoS One*. 2014; 9(6): e97551. doi: 10.1371/journal.pone.009755

5. Lutz A, Slagter HA, Dunne JD, Davidson RJ. Attention regulation and monitoring in meditation. *Trends Cogn Sci*. 2008; 12(4): 163-169. doi: 10.1016/j.tics.2008.01.005

6. Moore A, Malinowski P. Meditation, mindfulness and cognitive flexibility. *Conscious Cogn*. 2009; 18(1): 176-186. doi: 10.1016/j.concog.2008.12.008

7. Chiesa A, Calati R, Serretti A. Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review*. 2011; 31(3): 449-464. doi: 10.1016/j.cpr.2010.11.003

8. Malinowski P. Neural mechanisms of attentional control in mindfulness meditation. *Front Neurosci*. 2013; 7: 8. doi: 10.3389/fnins.2013.00008

9. Teper R, Inzlicht M. Meditation, mindfulness and executive control: The importance of emotional acceptance and brain-based performance monitoring. *Soc Cogn Affect Neurosci*. 2013; 8(1): 85-92. doi: 10.1093/scan/nss045

10. Lutz A, Slagter HA, Rawlings NB, Francis AD, Greischar LL, Davidson RJ. Mental training enhances attentional stabil-

ISSN 2380-727X Open Journal http://dx.doi.org/10.17140/PCSOJ-2-115

ity: Neural and behavioral evidence. *J Neurosci*. 2009; 29(42): 13418-13427. doi: 10.1523/JNEUROSCI.1614-09.2009

11. MacLean KA, Ferrer E, Aichele SR, et al. Intensive meditation training improves perceptual discrimination and sustained attention. *Psychol Sci*. 2010; 21: 829-839. doi: 10.1177/0956797610371339

12. Rosenberg M, Noonan S, DeGutis J, Esterman M. Sustaining visual attention in the face of distraction: A novel gradual-onset continuous performance task. *Atten Percept Psychophys*. 2013; 75(3): 426-439. doi: 10.3758/s13414-012-0413-x

13. Jensen CG, Vangkilde S, Frokjaer V, Hasselbalch SG. Mindfulness training affects attention-or is it attentional effort? *J Exp Psychol Gen*. 2012; 141(1): 106-123. doi: 10.1037/a0024931

14. Leonard NR, Jha AP, Casarjian B, et al. Mindfulness training improves attentional task performance in incarcerated youth: A group randomized controlled intervention trial. *Front Psychol*. 2013; 4: 792. doi: 10.3389/fpsyg.2013.00792

15. Jha AP, Krompinger J, Baime MJ. Mindfulness training modifies subsystems of attention. *Cogn Affect Behav Neurosci*. 2007; 7(2): 109-119. doi: 10.3758/CABN.7.2.109

16. van den Hurk PA, Giommi F, Gielen SC, Speckens AE, Barendregt HP. Greater efficiency in attentional processing related to mindfulness meditation. *Q J Exp Psychol (Hove)*. 2010; 63(6): 1168-1180. doi: 10.1080/17470210903249365

17. Golier J, Yehuda R, Cornblatt B, Harvey P, Gerber D, Levengood R. Sustained attention in combat-related post-traumatic stress disorder. *Integr Physiol Behav Sci.* 1997; 32(1): 52-61. doi: 10.1007/BF02688613

18. Horner MD, Hamner MB. Neurocognitive functioning in post-traumatic stress disorder. *Neuropsychology Review*. 2002; 12(1): 15-30. doi: 10.1023/A:1015439106231

19. Crowell TA, Kieffer KM, Siders CA, Vanderploeg RD. Neuropsychological findings in combat-related post-traumatic stress disorder. *Clinical Neuropsychology*. 2002; 16(3): 310-321. Web site. http://www.tandfonline.com/doi/abs/10.1076/clin.16.3.310.13851. Accessed June 13, 2016

20. Samuelson KW, Neylan TC, Metzler TJ, et al. Neuropsychological functioning in post-traumatic stress disorder and alcohol abuse. *Neuropsychology*. 2006; 20(6): 716-726. doi: 10.1037/0894-4105.20.6.716

21. Koso M, Hansen S. Executive function and memory in post-traumatic stress disorder: A study of Bosnian war veterans. *Eur Psychiatry*. 2006; 21(3): 167-173. doi: 10.1016/j.eurpsy.2005.06.004

22. Lagarde G, Doyon J, Brunet A. Memory and executive dysfunctions associated with acute post-traumatic stress disorder. *Psychiatry Res*. 2010; 177(1-2): 144-149. doi: 10.1016/j.psychres.2009.02.002

23. Horner MD, Mintzer JE, Turner TH, Edmiston KR, Brawman-Mintzer O. Attentional functioning in patients with post-traumatic stress disorder: A preliminary study. *CNS Spectr*. 2013; 18(2): 90-94. doi: 10.1017/S1092852912000909

24. Golier J, Yehuda R. Neuropsychological processes in post-traumatic stress disorder. *Psychiatr Clin North Am*. 2002; 25(2): 295-315. doi: 10.1016/S0193-953X(01)00004-1

25. Neylan TC, Lenoci M, Rothlind J, et al. Attention, learning and memory in post-traumatic stress disorder. *J Trauma Stress*. 2004; 17(1): 41-46. doi: 10.1023/B:JOTS.0000014675.75686.ee

26. Meewisse ML, Nijdam MJ, de Vries GJ, et al. Disaster-related post-traumatic stress symptoms and sustained attention: evaluation of depressive symptomatology and sleep disturbances as mediators. *J Trauma Stress*. 2005; 18(4): 299-302. doi: 10.1002/jts.20037

27. Vasterling JJ, Brailey K, Constans JI, Sutker PB. Attention and memory dysfunction in post-traumatic stress disorder. *Neuropsychology*. 1998; 12(1): 125-133. doi: 10.1037/0894-4105.12.1.125

28. Jenkins MA, Langlais PJ, Delis DA, Cohen RA. Attentional dysfunction associated with post-traumatic stress disorder among rape survivors. *Clin Neuropsychol*. 2000; 14(1): 7-12. Web site. http://www.tandfonline.com/doi/abs/10.1076/1385-4046%28200002%2914%3A1%3B1-8%3BFT007?journalCode=ntcn20. Accessed June 13, 2016

29. Falconer E, Bryant R, Felmingham KL, et al. The neural networks of inhibitory control in post-traumatic stress disorder. *J Psychiatry Neurosci*. 2008; 33(5): 413-422. Web site. http://jpn.ca/vol33-issue5/33-5-413/. Accessed June 13, 2016

30. Moore A, Gruber T, Derose J, Malinowski P. Regular, brief mindfulness meditation practice improves electrophysiological markers of attentional control. *Front Hum Neurosci*. 2012; 6: 18. doi: 10.3389/fnhum.2012.00018

31. Bardeen JR, Orcutt HK. Attentional control as a moderator of the relationship between post-traumatic stress symptoms and attentional threat bias. *J Anxiety Disord*. 2011; 25(8): 1008-1018. doi: 10.1016/j.janxdis.2011.06.009

32. Hussain A, Weisaeth L, Heir T. Psychiatric disorders and functional impairment among disaster victims after exposure to a natural disaster: A population based study. *J Affect Disord*. 2011; 128(1-2): 135-141. doi: 10.1016/j.jad.2010.06.018

ISSN 2380-727X Open Journal http://dx.doi.org/10.17140/PCSOJ-2-115

33. Heir T, Weisaeth L. Acute disaster exposure and mental health complaints of Norwegian tsunami survivors six months post disaster. *Psychiatry*. 2008; 71(3): 266-276. doi: 10.1521/psyc.2008.71.3.266

34. Conners CK. *Conner's CPT II, continuous performance test II.* North Tonawanda, NY, USA: MHS; 2009.

35. Baer RA, Smith GT, Lykins E, et al. Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment*. 2008; 15(3): 329-342. doi: 10.1177/1073191107313003

36. Bohlmeijer E, Ten Klooster PM, Fledderus M, Veehof M, Baer R. Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. *Assessment*. 2011; 18(3): 308-320. doi: 10.1177/1073191111408231

37. de Bruin EI, Topper M, Muskens JG, Bögels SM, Kamphuis JH. Psychometric properties of the Five Facets Mindfulness Questionnaire (FFMQ) in a meditating and a non-meditating sample. *Assessment*. 2012; 19(2): 187-197. doi: 10.1177/1073191112446654

38. Hou J, Wong SY, Lo HH, Mak WW, Ma HS. Validation of a Chinese version of the Five Facet Mindfulness Questionnaire in Hong Kong and development of a short form. *Assessment*. 2013; 21(3): 363-371. doi: 10.1177/1073191113485121

39. Lilja JL, Frodi-Lundgren A, Hanse JJ, et al. Five facets Mindfulness Questionnaire-reliability and factor structure: A Swedish version. *Cogn Behav Ther*. 2011; 40: 291-303. doi: 10.1080/16506073.2011.580367

40. Veehof MM, Ten Klooster PM, Taal E, Westerhof GJ, Bohlmeijer ET. Psychometric properties of the Dutch Five Facet Mindfulness Questionnaire (FFMQ) in patients with fibromyalgia. *Clin Rheumatol*. 2011; 30(8): 1045-1054. doi: 10.1007/s10067-011-1690-9

41. Dundas I, Vøllestad J, Binder P-E, Sivertsen B. The five factor mindfulness questionnaire in Norway. *Scand J Psychol*. 2013; 54(3): 250-260. doi: 10.1111/sjop.12044

42. Horowitz M, Wilner N, Alvarez W. Impact of event scale: A measure of subjective stress. *Psychosom Med*. 1979; 41(3): 209-218. Web site. http://journals.lww.com/psychosomaticmedicine/Abstract/1979/05000/Impact_of_Event_Scale__A_Measure_of_Subjective.4.aspx. Accessed June 13, 2016

43. Weiss DS. The impact of event scale-revised. In: Wilson JP, Keane TM, eds. *Assessing Psychological Trauma and PTSD*. 2nd ed. New York, NY, USA: Guilford Press; 2004: 168-189.

44. Beck AT, Steer RA, Brown GK. *Manual for the Beck Depression Inventory-II.* San Antonio, TX, USA: Psychological Corporation; 1996.

45. Beck AT, Steer RA. *Beck Anxiety Inventory manual.* San Antonio, TX, USA: Harcourt Brace and Company; 1993.

46. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: Psychometric properties. *J Consult Clin Psychol*. 1998; 56(6): 893-897. doi: 10.1037//0022-006X.56.6.893

47. Wechsler D. *Wechsler Abbreviated Scale of Intelligence manual (WASI)*. San Antonio, TX, USA: Psychological Corporation; 1999.

48. Johnsen GE, Kanagaratnam P, Asbjørnsen AE. Patients with post-traumatic stress disorder show decreased cognitive control: Evidence from dichotic listening. *J Int Neuropsychol Soc*. 2011; 17(2): 344-353. doi: 10.1017/S1355617710001736

49. Pole N. The psychophysiology of post-traumatic stress disorder: A meta analysis. *Psychol Bull*. 2007; 133(5): 725-746. doi: 10.1037/0033-2909.133.5.725