Supplemental Materials

Looking Inside the Black Box of Mindfulness Meditation: Investigating Attention and Awareness During Meditation Using the Mindful Awareness Task (MAT)

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Method

Participants

Sub-Sample with Previous Mindfulness Meditation Experience

Thirty-three participants in the sample reported previous mindfulness meditation practice, including: a regular mindfulness meditation practice (16 participants have/had 1 month to 3 years in which they practiced mindfulness meditation at least once a week); mindfulness meditations retreat(s) (12 participants completed 2-14 days in mindfulness retreats); and/or participated in mindfulness-based intervention or course, or in a mindfulness meditation group (19 participants completed 1-247 mindfulness meditation sessions).

Measures

Mindful Awareness Task (MAT)

Participants completed the MAT sitting on a chair in front of a computer (with a blank monitor) with their eyes closed. All instructions were administered via audio (using headphones), in line with common guided meditation practices (Crane et al., 2017; Kabat-Zinn, 2013; Segal et al., 2013). Participants completed three consecutive practice phases in which they gradually learned the task instructions. First, they learned and practiced a focused attention mindfulness meditation in which they were instructed to attend to the sensations of breathing, and to press a button on the keyboard whenever they noticed their inhalation or exhalation. Afterwards they learned and practiced an open monitoring mindfulness meditation in which they were instructed to monitor a wide range of prominent present moment experiences (e.g., sensations, emotions, thoughts) and to verbally state a label describing each experience they notice (e.g., “thinking”, “pain”, “calm”). Finally, they learned and practiced the MAT instructions which included the open monitoring mindfulness meditation instructions from the previous phase, with added instructions to direct their awareness to their breath when they do not notice any experience and press a button every time they notice their inhalation or exhalation. After this last practice phase, participants heard a reminder of the task instructions, and then completed the task for 20-minutes with their eyes closed and without hearing any instructions (i.e., measurement phase). All verbal labels and button presses were recorded, and their timing was documented using a computer program.

Objects of Mindful Awareness Scores. Verbal labels were transcribed and coded by three trained coders using a manualized coding scheme. All participants’ labels were coded by one main coder, and 60 participants were randomly selected and assigned (counterbalanced) to two additional coders (42% of sample) to enable inter-rater reliability tests. In line with established guidelines (Hruschka et al., 2004; Krippendorff, 2013), coding was conducted in two consecutive stages. During the preliminary coding training stage, each additional coder independently coded 6 sets of 2 randomly selected participants (17% of sample counterbalanced between the two additional coders), and after coding each set, all coders met to discuss coding disagreements. Subsequently, during the independent coding stage, each additional coder independently coded 18 randomly selected participants (25% of sample counterbalanced between the two additional coders), and coders did not discuss coding until they finished coding. This coding procedure ensured coders received sufficient training in coding, while also enabling a test of the reliability between independent coders.

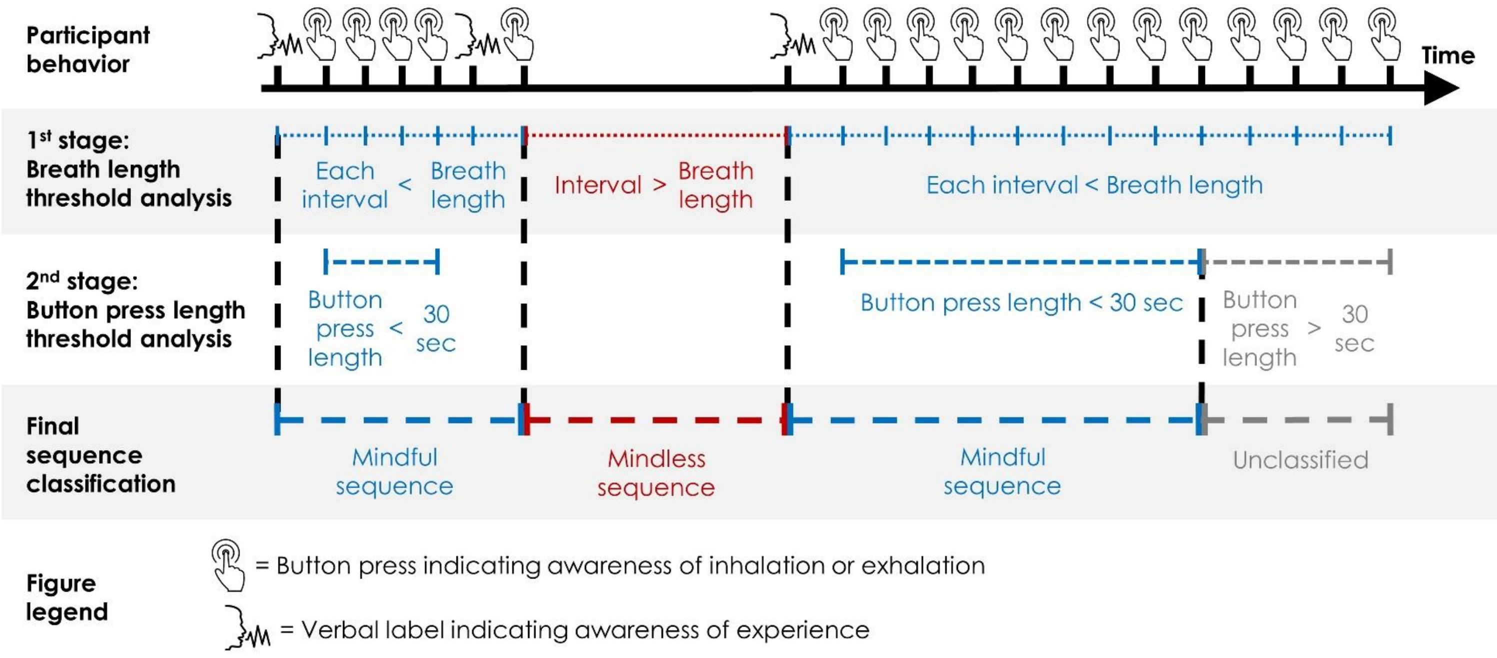
During the coding procedure six codes representing objects of mindful awareness could be applied to each label. The code *meta-awareness* was applied to labels representing awareness of present moment subjective experiences or present moment cognitive processes (e.g., “sensation” or “thinking”; “money” or “movie” will not get this code). The meta-awareness code was a precondition for applying each of the other codes, as each of them represents meta-awareness of a particular type of experiential objects. The code *body* was applied to labels representing awareness of bodily sensations or sense impressions (e.g., “cold” or “sound”). The code *mind* was applied to labels representing awareness of mental phenomena (e.g., “thinking” or “happy”). The code *thought* was applied to labels representing awareness of thinking processes (e.g., “thinking” or “worried”; all labels coded as ‘thought’ were also coded as ‘mind’). The code *pleasant* was applied to labels representing awareness of pleasant experience (e.g., “pleasure”, “fun”), and the code *unpleasant* was applied to labels representing awareness of unpleasant experience (e.g., “pain”, “fear”). Finally, the number of labels reflecting meta-awareness, and mindful awareness of body, mind, thoughts, pleasant and unpleasant hedonic tone were tallied per participant to quantify the frequencies of mindful awareness of these experiential objects.

Temporal Dynamics of Mindful Awareness Scores. To calculate the temporal dynamics of mindful awareness, the timing and order of all labels and button presses were analyzed using an algorithm to divide and classify the 20-min meditation into mindful sequences, mindless sequences and sequences that could not be classified as mindful or mindless (i.e., unclassified). These sequences were classified in two consecutive stages using two empirically validated thresholds.

In the first stage, a *breath length threshold* was computed for each participant based on the duration of intervals between consecutive button presses to estimate her/his average breath length (inhalation and exhalation). Intervals between successive button presses and/or labels equal or shorter than the breath length threshold were classified as mindful and combined with adjacent mindful intervals into mindful sequences (see Figure S1). Intervals between successive button presses and/or labels longer than the breath length threshold were classified as mindless sequences (see Figure S1). Three seconds were added to the breath length threshold for intervals that included a label to correct for the time a label is vocalized. The logic and necessity for the breath length threshold sequences classification stage is as follows. By design and per MAT instructions, a participant that is mindful during an inhalation or an exhalation should either notice the inhalation/exhalation and therefore press a button or notice an experience and therefore say a label. Because a participant may press a button or say a label at the very beginning or end of each inhalation or exhalation, the maximal interval between *successive* button presses and/or labels that indicates a participant engaged in mindful awareness is the length of a single breath cycle. Accordingly, an interval between successive button presses and/or labels that is longer than a participants' single breath length indicates a participant did *not* engage in mindful awareness during that interval – a state we refer to here as mindless. For further support of this classification stage see subsection testing whether slowing of the breath can lead to incorrect classification of mindless sequences (in the Supplemental Materials (SM) Results section below).

Figure S1

MAT Mindful and Mindless Sequences Classification



Note. Sequences were classified in two consecutive stages. In the first stage, time intervals between successive button presses and/or labels equal or shorter than each participants' estimated average breath length were classified as mindful, and combined with adjacent mindful intervals into mindful sequences. Time intervals between successive button presses and/or labels longer than the estimated average breath length were classified as mindless sequences. In the second stage, time intervals between successive button presses that occurred after a 30-sec button press period, and that were classified as mindful in the first stage, were recoded as unclassified (i.e., not classified as either mindful or mindless) and were excluded from mindful sequences.

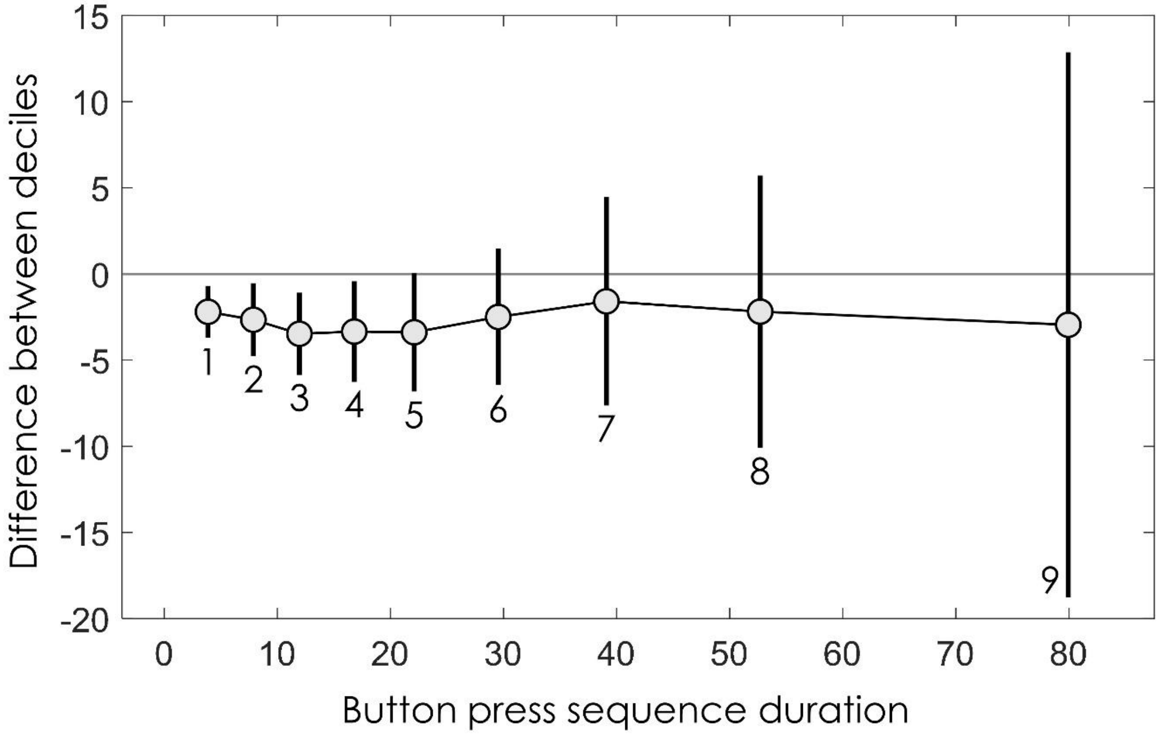
In the second stage, a 30-sec *button press length threshold* was used to produce more accurate estimates of the durations of mindful sequences. Intervals between successive button presses that occurred after a 30-sec period of button presses with no labels could not be classified as mindful and were accordingly excluded from mindful sequences (see Figure S1). In the event that these intervals were classified as mindful in the first stage, they were re-coded in this stage as unclassified (i.e., neither mindful nor mindless). The logic and necessity for the button press length threshold sequences classification stage is as follows. By design and per MAT instructions, participants were instructed to engage in open monitoring of (and labeling of) present moment experience, and to direct their awareness to their breath (and press the button) only when they do not notice any experience other than the breath. Thus, long sequences of successive button presses without any labels (i.e., button press sequences) indicate a failure to monitor and notice present moment experience other than the breath, and therefore a failure to engage in mindful awareness according to task instructions. Likewise, long button press sequences may be indicative of lapses in mindful awareness – previous research has found that repetitive and automatic button pressing in cognitive tasks is linked to mind-wandering without meta-awareness (Smallwood et al., 2007). Thus, to estimate the time point in which lapses in sustained mindful awareness are more likely to occur during button press sequences, a shift function analysis was conducted (for details see SM subsection – button press sequences shift function analysis). This analysis revealed that lapses in sustained mindful awareness in button press sequences may be more likely to occur after 30-sec than during the first 30-sec in these sequences. Thus, intervals in button press sequences occurring after the first 30-sec in the sequence could not be confidently classified as mindful, and therefore were excluded from mindful sequences.

Next, based on the mindful and mindless sequence classification, the temporal dynamics of mindful awareness scores were computed. To estimate the amount of time each participant engaged in mindful awareness during the MAT meditation, a *mindful awareness time score* was computed by summing the duration of all mindful sequences. To estimate capacity to sustain mindful awareness without significant interruptions, a *sustained mindful awareness score* was computed as the mean duration of all mindful sequences. Finally, to estimate the latency of re-engagement in mindful awareness following the onset of mindless states, a *latency to re-engagement in mindful awareness score* was computed as the mean duration of all mindless sequences. In case a participant did not have any mindless sequences (5.6% of sample), the latency to re-engagement in mindful awareness score was determined as his/her *breath length threshold*. This enabled a conservative estimation of this phenomena because mindless states shorter than this threshold could not be detected.

Button press sequences shift function analysis. For this analysis we identified button press sequences followed by labels coded as *thought*, indicating meta-awareness of thoughts and thereby the occurrence of thinking or mind-wandering during the end of the button press sequence (22.5% of button press sequences). These sequences have a higher likelihood to contain lapses in sustained mindful awareness compared to button press sequences followed by labels indicating meta-awareness and not coded as *thought* (65.5% of button press sequences). To estimate the time-point in which lapses in sustained mindful awareness are more likely to occur during button press sequences, we conducted a shift function analysis comparing the distributions of the durations of these two types of button press sequences (Rousselet et al., 2017). The shift function graph indicated that the two distributions differed from each other in the expected direction for button press sequence durations shorter than ~30-sec (6^{th} decile), but did not differ for durations equal or above ~30-sec (See Figure S2). Thus, button press sequences shorter than ~30-sec were followed by fewer indications for lapses in sustained mindful awareness (labels indicating thinking and mind-wandering) compared to button press sequences equal or greater than ~30-sec. Therefore, the shift function analysis indicated that lapses in sustained mindful awareness in button press sequences may be more likely to occur after 30-sec, than during the first 30-sec in these sequences.

Figure S2

Button Press Sequences Shift Function Graph



Note. Each grey circle represents one decile of the distribution of durations of button press sequences. The vertical lines above and below each circle represent 95% simultaneous confidence intervals of the difference between deciles in the duration distributions of button press sequences with a high vs. low likelihood to contain lapses in sustained mindful awareness. This difference was computed by subtracting the deciles of the duration of sequences followed by labels indicating thinking and mind-wandering (i.e., higher likelihood for lapses) from corresponding deciles of the duration of sequences followed by other labels indicating meta-awareness (i.e., lower likelihood for lapses). Deciles were computed using Harrell-Davis quantile estimator, and confidence intervals were computed using percentile bootstrap estimation of deciles' standard errors with 1,000 bootstrap samples (Figure created with code from: Rousselet, 2017).

Sustained Attention to Response Task (SART)

During the task, a digit from 1 to 9 was presented in each trial, and participants were instructed to respond by pressing a button for each digit presented, except when the digit 3 appeared, in which case they were to withhold the button press (see Robertson et al. (1997) for more details). The task included 36 practice trials followed by 225 measurement trials. An index of transient disengagements of attention from the dynamic features of a visual task was scored by computing a coefficient of reaction time variability for measurement trials (reaction time variability: $CV_{RT} = SD_{RT}/Mean_{RT}$) (Cheyne et al., 2009). An index of inattention to visual information and motor behavior was scored by tallying the number of response errors to the infrequent target stimuli (digit 3) in measurement trials (i.e., failing to withhold button presses – commission errors; Cheyne et al., 2009; Seli, 2016).

Alternating-Runs Task Switching Paradigm (ARTS)

In each trial of the task a letter and a digit were presented in one of four adjacent squares on the computer monitor. If the stimuli were presented in one of the two upper squares, then participants were to categorize the letter as a vowel or consonant; if the stimuli were presented in one of the lower two squares, then participants were to categorize the digit as odd or even. In *mixed-tasks* blocks the stimulus location changed in a clockwise manner from trial to trial, so that participants always performed two consecutive letter categorizations followed by two consecutive digit categorizations (Rogers & Monsell, 1995). In a *single-task* blocks participants performed only a letter categorization or a digit categorization task (Kiesel et al., 2010). See Table S1 for description and order of all blocks.

Table S1

Alternating-Runs Task Switching Paradigm Procedure

Block type	Task(s)	Number of trials
Single-task practice	Letter categorization	16
Single-task measurement	Letter categorization	40
Single-task practice	Digit categorization	16
Single-task measurement	Digit categorization	40
Mixed-tasks practice	Letter & digit categorization	32
Mixed-tasks measurement	Letter & digit categorization	80
Mixed-tasks measurement	Letter & digit categorization	80
Mixed-tasks measurement	Letter & digit categorization	80
Mixed-tasks measurement	Letter & digit categorization	80
Single-task measurement	Letter categorization	40
Single-task measurement	Digit categorization	40

A *switching cost index* representing impaired task-set reconfiguration was scored by computing differences in reaction times between two types of trials in the mixed-tasks blocks: switch trials in which participants had to switch between tasks, and repetition trials in which participants performed the same task as in the previous trial (Rogers & Monsell, 1995). A *mixing cost index* representing impaired task set competition management was scored by computing differences in reaction times between repetition trials in mixed-tasks blocks, in which participants repeated a task in a block that included another task, and single-task trials, in each of which only one task was performed in the block (Rubin & Meiran, 2005).

Self-Report Scales

Assessment of Previous Meditation Experience. The *previous meditation experience questionnaire* was composed based on existing guidelines (King et al., 2019; Lutz et al., 2007; Van Dam et al., 2018) to assess participants previous experience in meditation, including the number of months of regular meditation practice (at least once a week), number of days in meditations retreat(s), and number of meditation sessions (in mindfulness-based interventions or courses, or in mindfulness meditation groups). Participants described the meditation style(s) they practiced regularly at home, in retreats, and/or in meditation sessions. In the event that participants provided ambiguous information regarding the meditation style(s) they practiced in the questionnaire (e.g., sitting meditation), a follow-up phone interview was conducted to clarify. All meditation retreats, meditation sessions, and months of regular meditation practice were classified as entailing practice of mindfulness meditation, or as entailing practice of meditations that do not emphasize the cultivation of mindfulness (e.g., transcendental meditation, guided imagination) according to participant's descriptions of meditation styles. Meditations described as including present moment attention and awareness were coded as mindfulness meditations, and all other meditations were coded as not emphasizing the cultivation of mindfulness.

Hebrew Translations of Self-Report Scales. Most of the Hebrew translations of scales in the study were previously used in studies in which they displayed acceptable to excellent psychometric properties: *Mindful Attention Awareness Scale* (Hadash, Segev, et al., 2016; Hadash et al., 2017; Tanay et al., 2012; Tanay & Bernstein, 2013), *Five Facet Mindfulness Questionnaire* (Hadash et al., 2017; Hadash, Plonsker, et al., 2016; Tanay & Bernstein, 2013), *State Mindfulness Scale* (Hadash, Segev, et al., 2016; Tanay et al., 2012; Tanay & Bernstein, 2013), *Drexel Defusion Scale* (Hadash et al., 2017; Hadash, Plonsker, et al., 2016), *Toronto Mindfulness Scale – Curiosity* sub-scale (Tanay & Bernstein, 2013), *Patient Health Questionnaire*-9 (Amir et al., 2021; Hadash et al., 2017), *Penn State Worry Questionnaire* (Amir et al., 2021), *Beck Anxiety Inventory* (Amir et al., 2021; Hadash et al., 2017; Hadash, Plonsker, et al., 2016).

Internal Reliabilities of Self-Report Scales

Table S2

Cronbach's Alpha Coefficients of Self-Report Scales and Subscales

Scale/subscale	α
MAAS	.86
FFMQ-observing	.72
FFMQ-describing	.88
FFMQ-acting with awareness	.90
FFMQ-non judging	.91
FFMQ-non reactivity	.70
SMS-total	.93
SMS-body	.77
SMS-mind	.91
MAIA-noticing	.78
MAIA-emotional awareness	.84
MAIA-self-regulation	.80
MAIA-attention regulation	.88
DDS	.84
TMS-curiosity	.90
ACS	.86
MWQ	.84
PHQ-9	.87
PSWQ	.93
BAI	.90

Note. N = 143.

MAAS = Mindful Attention Awareness Scale; FFMQ = Five Facet Mindfulness Questionnaire; SMS = State Mindfulness Scale; MAIA = Multidimensional Assessment of Interoceptive Awareness; DDS = Drexel Defusion Scale; TMS = Toronto Mindfulness Scale; ACS = Attentional Control Scale; MWQ = Mind-Wandering Questionnaire; PHQ-9 = Patient Health Questionnaire-9; PSWQ = Penn State Worry Questionnaire; BAI = Beck Anxiety Inventory.

Wording of Experience Samples of State Mindfulness Processes

Table S3

ES Items Wording

ES name	ES item wording
Meta-awareness	I often paid attention to physical sensations, emotions or thoughts
MA of body	I noticed physical sensations (other than the breath)
MA of mind	I noticed emotions and thoughts
MA of pleasant[a]	I noticed pleasant physical sensations, emotions or thoughts when they occurred
MA of unpleasant[a]	I noticed unpleasant physical sensations, emotions or thoughts when they occurred
Sustained MA	I noticed present moment experiences (such as: the breath, physical sensations, emotions or thoughts) without interruptions for long periods of time
Latency to MA[b]	When my thoughts wondered I could quickly notice that, and redirect my attention to the present moment

Note. The following instructions were presented before the items "Please indicate how much each statement describes what you experienced during the last part of the task you performed (the last 20 minutes in which you performed the task, and no instructions were heard)". All items were rated on a 1-9 Likert scale (1 = not at all, 3 = a little, 5 = moderately, 7 = mostly, 9 = very much). Items and instructions were presented in Hebrew. Experience samples of mindful awareness of body, mind, pleasant, and unpleasant experience were tested as measures of mindfulness in a previous study (Hadash, Plonsker, et al., 2016).

ES = Experience Sample; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness.

[a] In these items an additional response option was presented: "I had no pleasant experiences at all" or "I had no unpleasant experiences at all". Participants selecting these response options were removed from analyses that included the item.

[b] ES was reverse scored.

Results

Testing Whether Slowing of Breathing Can Lead to Incorrect Classification of Mindless Sequences

We examined whether the slowing of breathing over the course of the MAT measurement phase could lead to incorrect classification of mindless sequences. First, we tested whether breath length (the length of intervals between successive button presses) was associated with MAT measurement time across all participants (after removing 1.3% outlier of intervals which are >3*SD* than the average interval length and are likely created by mindless states and not by slowing of the breath). We found no evidence of a meaningful association (r = .015, p = .002) indicating that breathing did not systematically slow over the course of the MAT measurement phase.

Second, for incorrect classification of mindless sequences to occur, a participant's breathing needs to slow to an extent that breath length is more than twice the length of her/his average breath length in the meditation (with slow breath cycles included in the calculation of the average breath length; see description of breath length threshold computation in the Mindful Awareness Task measure description in the SM). Accordingly, we examined whether breathing may slow to such an extent, and thereby lead to incorrect classification of mindless sequences. To do so, we calculated the coefficient of variation ($\frac{SD}{M}$) of intervals between successive button presses to estimate breath length variability (after removing outliers >3SD above the average interval length which are not likely created by slowing of the breath). We found that the average $\frac{SD}{M}$ = .36, indicating that participant's estimated breath length SD was approximately one third of their breath length mean duration. Importantly, this ratio is most likely inflated by mindless states (leading to no button presses during inhalations or exhalations), and thus is an over estimation of the actual variation in breath length. Importantly, even this conservative estimate of relative breath length variability demonstrates that a participant's breath length needs to increase by a magnitude of ~3SD above her/his average breath length to cause incorrect classification of mindless sequences (i.e., breath length > 2 X average breath length). Thus, findings suggest that incorrect classification of mindless sequences due to slowing of breathing or changes in breath length are very unlikely.

Reliability of MAT Scores

Objects of Mindful Awareness Inter-Rater Reliabilities

One main coder coded all participants and 42% of participants were randomly selected and counterbalanced between two additional coders. Coding was conducted in two consecutive stages: a coding training stage and an independent coding stage (see Objects of Mindful Awareness Scores subsection in SM for details on stages). In both stages inter-rater reliabilities of the objects of mindful awareness scores were excellent (ICCs > .90; see Table S4).

Table S4

Inter-Rater Reliabilities for Objects of Mindful Awareness Scores in the Two Coding Stages

MAT score	Coding training stage ICC (n=24)	Independent coding stage ICC (n=36)
Meta-awareness	.99	.99
MA of body	.99	.99
MA of mind	.98	.99
MA of thoughts	.99	.98
MA of pleasant	.99	.95
MA of unpleasant	.99	.97

Note. All ICCs are one-way random effects ICCs testing for absolute agreement for a single measurement (Koo & Li, 2016; McGraw & Wong, 1996). ICCs were computed on Log10 transformation of scores because non-transformed values were skewed (see MAT Scores Skewness section).

MAT = Mindful Awareness Task; ICC = Intraclass Correlation Coefficient; MA = Mindful Awareness.

Aim 1: Empirically Characterizing Attention and Awareness During Mindfulness Meditation

MAT Scores Skewness

All MAT scores except for total mindful awareness time were positively skewed, and Log10 transformations reduced skewness levels of these scores (see Table S5).

Table S5

Skewness of MAT Scores

Dimension	MAT score	Skewness of non-transformed score	Skewness of Log10 transformed score
Objects of MA	Meta-awareness	1.43	-0.85
	MA of body	2.12	-0.32
	MA of mind	1.56	-0.33
	MA of thoughts	1.88	0.09
	MA of pleasant	2.53	0.81
	MA of unpleasant	2.87	-0.34
Temporal dynamics of MA	MA time	0.15	[a]
	Sustained MA	5.13	1.16
	Latency to MA	3.48	0.52

Note. Because some of the objects of MA scores had 0 values, a value of 1 was added to these scores before conducting Log10 transformations. N = 143.

MAT = Mindful Awareness Task; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness.

[a] Log10 transformation was not conducted because the non-transformed score was not skewed.

MAT Scores Floor and Ceiling Effects

We tested for floor and ceiling effects by examining the percentage of participants that received the minimum and maximum values of each MAT score (see Table S6). None of the MAT scores displayed evidence for a ceiling effect (0.7%-1.4% of participants received the maximum value). The mindful awareness of pleasant experience score displayed evidence for a substantive floor effect (46.2% of participants received the minimum value); the mindful awareness of thoughts displayed evidence for a moderate floor effects (19.6%); the mindful awareness of body, mind and unpleasant experience displayed small evidence for a floor effect (7%-10.5%); and all other scores displayed no evidence for a floor effect (0.7%-2.8%). Observed floor effects may result from a limitation in the MAT methodology, or alternatively may represent the actual distribution of the objects of mindful awareness.

Table S6

Tests of Floor and Ceiling Effects of MAT Scores

Dimension	MAT score	Minimum value[a]	% of participants with minimum value	Maximum value[a]	% of participants with maximum value
Objects of MA	Meta-awareness	0	2.8%	98	0.7%
	MA of body	0	10.5%	74	0.7%
	MA of mind	0	7%	39	0.7%
	MA of thoughts	0	19.6%	34	0.7%
	MA of pleasant	0	46.2%	11	1.4%
	MA of unpleasant	0	10.5%	59	0.7%
Temporal dynamics of MA	MA time	6.67 sec (0.6%)	0.7%	1,178.86 sec (98.2%)	0.7%
	Sustained MA	6.67 sec	0.7%	392.95 sec	0.7%
	Latency to MA	3.06 sec	0.7%	64.46 sec	0.7%

Note. N = 143.

MAT = Mindful Awareness Task; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness.

[a] Because Log10 transformed scores are difficult to interpret, non-transformed scores are presented in these columns.

Differences between MAT Scores among Participants with Previous Mindfulness Meditation Practice

A comparison of MAT scores among the sub-sample of participants with previous mindfulness meditation practice was conducted to test whether the differences between scores were also evident among mindfulness meditators. Similar to findings in the total sample, participants with previous mindfulness meditation practice had a significantly longer average duration of sequences of sustained mindful awareness than sequences of mindless states ($t(32) = 6.78$, $p <. 001$, Cohens' $d = 1.18$); and demonstrated a much higher frequency of mindful awareness of unpleasant than pleasant experience ($t(32) = 8.85$, $p <. 001$, Cohens' $d = 1.54$). However, they displayed no significant difference between the frequency of mindful awareness of their body and their mind ($t(32) = 1.24$, $p = .22$, Cohens' $d = 0.22$). This non-significant difference may be due to the small sub-sample of participants with previous mindfulness meditation practice ($n = 33$), reducing the statistical power needed to find a relatively small effect (power = .80 for detecting Cohen's d > .44).

Aim 2: Whether and How Previous Meditation Practice Predicts Attention and Awareness During Mindfulness Meditation

Does Previous Practice of Meditation Styles that Do Not Emphasize the Cultivation of Mindfulness Predict Attention and Awareness During Mindfulness Meditation?

No significant differences were found on mindfulness processes during meditation measured by the MAT between participants with previous practice of meditation styles that *do not* emphasize the cultivation of mindfulness (n = 14; e.g., transcendental meditation), and those with no meditation practice at all (n = 96) (model $F(9,100) = 1.04$, $p = .41$, $\eta_p^2 = 0.09$).

Are Attention and Awareness During Mindfulness Meditation Associated with the Number of Months of Regular Mindfulness Meditation Practice?

See Table S7 for correlations between mindfulness processes measured via the MAT and number of months of regular practice of mindfulness meditation.

Table S7

Correlations Between Mindfulness Processes Measured via the MAT and Number of Months of Previous Mindfulness Meditation Practice

	Months of regular practice of mindfulness meditation	
MAT score	*r*	*p*
Meta-awareness[a]	.51*	.04
MA of body[a]	.52*	.04
MA of mind[a]	.34	.20
MA of thoughts[a]	.24	.37
MA of pleasant[a]	.14	.62
MA of unpleasant[a]	.38	.14
MA time	.70**	.003
Sustained MA[a]	.87***	<.001
Latency to MA[a]	-.29	.27

Note. Pearson correlations were calculated among participants that have/had a regular mindfulness meditation practice (i.e., at least once a week). N = 16.

MAT = Mindful Awareness Task; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness.

[a] Log10 transformed score because non-transformed values were skewed (see MAT Scores Skewness section).

* $p < .05$ ** $p < .01$ *** $p < .001$.

Aim 3: Whether and How Attention and Awareness During Mindfulness Meditation are Associated with Attitudinal Qualities of Mindfulness, Attention Regulation, and Mental Health

See Table S8 for stepwise linear regression models testing which specific mindfulness processes during meditation measured by the MAT uniquely predict indices reflecting attitudinal qualities of mindfulness, attention (dys)regulation, and mental health.

Table S8

Stepwise Regression Models Testing Associations Between Mindfulness Processes Measured via the MAT and Attitudinal Qualities of Mindfulness, Attention (Dys)Regulation, and Mental Health

Predicted variables	MAT predictors	*R*	*F*	*df*	*p*	*sr*	*t*	*p*
Decentering (DDS)		.29	6.30**	2, 140	.002			
	MA time					.27	3.32**	.001
	MA of pleasant[a]					-.19	-2.32*	.022
Curiosity (TMS)		.30	6.99**	2, 140	.001			
	MA of pleasant[a]					.19	2.38*	.018
	Sustained MA[a]					.18	2.28*	.024
Self-regulation (MAIA)		.29	13.00***	1, 141	<.001			
	MA of mind[a]					.29	3.61***	<.001
Attention regulation (MAIA)		.21	6.19*	1, 141	.014			
	Latency to MA[a]					-.21	-2.49*	.014
Attentional control (ACS)		.32	5.39**	3, 139	.002			
	MA of thoughts[a]					-.28	-3.43***	<.001
	Latency to MA[a]					-.16	-1.98*	.049
	MA of body[a]					.16	1.98*	.050
Mind wandering (MWQ)		.29	6.61**	2, 140	.002			
	Latency to MA[a]					.24	2.92**	.004
	MA of thoughts[a]					.20	2.45*	.016
Depression (PHQ-9)		.34	5.92***	3, 139	<.001			
	Latency to MA[a]					.20	2.55*	.012
	MA of unpleasant[a]					.27	3.44***	<.001

	MA of mind[a]					-.17	-2.12*	.035
Worry (PSWQ)		.27	5.71**	2, 140	.004			
	MA of unpleasant[a]					.27	3.36***	<.001
	MA time					-.19	-2.38*	.019
Anxiety (BAI)		.22	6.98**	1, 141	.009			
	MA of unpleasant[a]					.22	2.64**	.009

Note. All MAT scores were possible predictors in each regression model. Stepwise regression *p* entry of a predictor to the model was set to $\leq .05$, and *p* value for removal of a predictor from the model was set to $\geq .10$. No MAT scores were removed from models. All parameters in the table reflect the last step in each stepwise regression, in which no MAT scores were eligible for entry or removal from the model. Models for FFMQ non-judging and non-reactivity subscales were not created because no MAT scores were significantly associated with predicted values. In all stepwise regression models multicollinearity indices indicated no problems related to multicollinearity (VIF_{range} = 1 to 1.638; $tolerance_{range}$ = .610 to 1). N = 143.

sr = Semipartial correlation; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness; DDS = Drexel Defusion Scale; TMS = Toronto Mindfulness Scale; MAIA = Multidimensional Assessment of Interoceptive Awareness; ACS = Attentional Control Scale; MWQ = Mind-Wandering Questionnaire; PHQ-9 = Patient Health Questionnaire-9; PSWQ = Penn State Worry Questionnaire; BAI = Beck Anxiety Inventory.

[a] Log10 transformed score because non-transformed values were skewed (see MAT Scores Skewness section).

**p* < .05 ***p* < .01 ****p* < .001.

Aim 4: Psychometric Performance of the MAT Relative to Self-Report Measures and Cognitive-Experimental Tasks in Measuring Mindful Awareness

Aim 4b: Breusch–Pagan Heteroscedasticity Tests

See Table S9 for heteroscedasticity tests of associations between Behavioral and self-reported mindful awareness.

Table S9

Breusch–Pagan Heteroscedasticity Tests of Associations Between Behavioral and Self-Reported Mindful Awareness

MAT score and self-report score	Breusch–Pagan heteroscedasticity test Lagrange multiplier	Breusch–Pagan *p*
Behavioral mindfulness and self-reported *state* mindfulness		
MAT meta-awareness and ES meta-awareness	19.47[a]***	<.001
MAT MA of body and ES MA of body	19.14[a]***	<.001
MAT MA of mind and ES MA of mind	13.12[a]***	<.001
MAT MA of pleasant and ES MA of pleasant	6.52[a]*	.01
MAT MA of unpleasant and ES MA of unpleasant	21.36[a]***	<.001
MAT sustained MA and ES sustained MA	0.16[a]	.69
MAT latency to MA and ES latency to MA	3.06[a]	.08
MAT MA time and SMS-total	4.40*	.04
MAT MA of body and SMS-body	4.76[a]*	.03
MAT MA of mind and SMS-mind	4.07[a]*	.04
MAT MA of thoughts and SMS-mind	3.74[a]	
Behavioral mindfulness and self-reported *trait* mindfulness		
MAT MA of body and FFMQ-observing	0.28[a]	.59
MAT MA of mind and MAIA-emotional awareness	0.12[a]	.73
MAT latency to MA and FFMQ-acting with awareness	0.58[a]	.45

Note. Heteroscedasticity tests were only conducted on significant associations (see Table 4 in paper for all significant and non-significant of associations). N = 143.

MAT = Mindful Awareness Task; ES = Experience Sampled; MA = Mindful Awareness; Latency to MA = latency to re-engagement in mindful awareness; SMS = State Mindfulness Scale; FFMQ = Five Facet Mindfulness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness.

*$p < .05$ ***$p < .001$.

[a] Computed on Log10 transformation of MAT score because non-transformed values were skewed (see SM).

Aim 4d: Is Previous Mindfulness Meditation Practice Related to Self-Reported Mindfulness?

We used MANOVA to test the differences between participants with (n = 33) and without (n = 110) previous mindfulness meditation practice on self-reported trait mindfulness vis-a-vis the Five Facet Mindfulness Questionnaire and Mindful Attention Awareness Scale, and state mindfulness during the MAT mindfulness meditation vis-à-vis the State Mindfulness Scale. Although significant and large differences were observed, these differences were in the direction *opposite* to theory and prediction (model $F(7,135) = 3.25$, $p = .003$, $\eta_p^2 = 0.14$). Specifically, participants with previous mindfulness meditation practice demonstrated significantly *lower* mindfulness scores than participants with no previous practice on two trait (sub)scales (see Table S10); and no significant differences were observed for the remaining 5 trait and state scales and sub-scales between participants with and without previous mindfulness meditation experience (see Table S10).

Table S10

T-tests and Descriptive Statistics for Self-Reported Mindfulness by Previous Mindfulness Meditation Practice

	Participants with previous mindfulness meditation practice (n = 33)	Participants without previous mindfulness meditation practice (n = 110)				
Self-report scale	*M (SD)*	*M (SD)*	*t*	*df*	*p*	Hedges' *g*
MAAS-total	3.78 (0.62)	4.35 (0.71)	-4.14***	141	<.001	-0.82
FFMQ-observing	3.32 (0.64)	3.21 (0.68)	0.80	141	.43	0.16
FFMQ-describing	3.58 (0.78)	3.71 (0.74)	-0.88	141	.38	-0.17
FFMQ-acting with awareness	3.21 (0.70)	3.75 (0.72)	-3.78***	141	<.001	-0.75
FFMQ-non judging	3.43 (1.03)	3.59 (0.89)	-0.88	141	.38	-0.17
FFMQ-non reactivity	2.96 (0.55)	2.95 (0.66)	0.07	141	.95	.01
SMS-total	3.70 (0.62)	3.66 (0.72)	0.34	141	.73	.07

Note. Scale and sub-scale scores were computed as means of item ratings. MAAS ratings were conducted on a 1-6 Likert scale, and FFMQ and SMS ratings were conducted on a 1-5 Likert scale.

MAAS = Mindful Attention Awareness Scale; FFMQ = Five Facet Mindfulness Questionnaire; SMS = State Mindfulness Scale.

*** $p < .001$.

Aim 4d: Is Previous Mindfulness Meditation Practice Related to Attentional Processes Measured Via Cognitive-Experimental Tasks?

We used MANOVA to test the differences between participants with (n = 33) and without (n = 110) previous mindfulness meditation practice on levels of sustained visual attention (Sustained Attention to Response Task; SART) and levels of interference between competing tasks (Alternating-Runs Task Switching; ARTS). There were no differences between the groups on sustained visual attention (SART reaction time variability or commission errors; model $F(2,140) = 0.76$, $p = .47$), nor on interference between competing tasks (ARTS switching cost and mixing cost; model $F(2,140) = 1.34$, $p = .27$).

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