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What is the Most Helpful Body-Scan Posture for People with Attention-Deficit/Hyperactivity Disorder Tendency?

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Abstract: We explored body-scan postures suitable for people with attention-deficit/hyperactivity disorder (ADHD) tendency by developing and validating the Mindfulness Encouraging/Discouraging Reactions Scales (MERS/MDRS), using university students. In Study 1, we conducted a survey to collect typical positive and negative reactions during mindfulness exercises from 21 participants and created the preliminary items. In Study 2, 192 participants completed existing state/trait mindfulness scales and the preliminary MERS and MDRS after mindful breathing. Based on an item response model, we developed and validated MERS and MDRS. In Study 3, 19 participants were categorized into one of four groups: (a) combined, (b) hyperactive/impulsive, (c) inattentive, and (d) without ADHD tendencies. They performed body-scan meditations with each of the counterbalanced postures (upright, slumped, leaning-back sitting, and supine), and completed the questionnaires. The analysis showed that those with hyperactivity/impulsivity tendency found the body-scan meditation a challenge with the slumped posture and easier to perform in the supine posture; the upright posture provided high and low MERS to the hyperactivity/impulsivity tendency group and combined group, respectively; and sleepiness correlated with MERS in the supine posture ($r = .49$) and the upright posture ($r = .51$). We identified helpful body scan postures for people with ADHD tendency, using MERS and MDRS, but it was noted that these scales were created solely based on intuitive impressions for beginners, and it is not recommended that the items included in them be aimed for or avoided.

Key words: ADHD, mindfulness, body position, intervention, meditation.

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by persistent inattention, hyperactivity/impulsivity, or both, found among 2.5% of adults in most cultures (American Psychiatric Association, 2013). Individuals with ADHD tendency experience these and a variety of other symptoms, such as anxiety, depression, personality disorders (Poissant et al., 2019), low self-esteem (Hesslinger et al., 2002), academic failure (Weyandt et al., 2013), and emotional problems (Zylowska, 2012). Therefore, the approach to caring for individuals with ADHD tendency needs to be holistic so that not only are the main symptoms of mental illness relieved, but the individuals' social functioning and quality of life are improved.

Recently, mindfulness has attracted attention as a holistic and alternative approach.

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Mindfulness, often defined as paying attention "on purpose, in the present moment, and non-judgmentally" (Kabat-Zinn, 1994), has been used in various fields. In medicine, for example, mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) has improved lifestyle-related conditions, such as smoking, dietary behaviors, and hypertension (Williams et al., 2015), and mindfulness-based cognitive therapy (MBCT) has been developed to treat depression (Segal et al., 2002). It is also revealed that mindfulness training has contributed to improving academic performances (Franco et al., 2011) and working memory tasks in university students through the mediation of mind-wandering reduction (Mrazek et al., 2013).

ADHD and Mindfulness Practices

Mindfulness-based training programs have been shown to improve ADHD symptoms. Cairncross and Miller (2020) conducted a meta-analysis to compare ADHD symptoms between, before, and after intervention in individuals diagnosed with ADHD. They found that mindfulness-based training, such as MBSR and MBCT, reduced the symptoms of inattention ($d = 0.66$) and hyperactivity/impulsivity ($d = 0.53$) in individuals diagnosed with ADHD. Further, a systematic review on experimental studies examined the effects of mindfulness interventions on adults with ADHD and found that all 13 studies showed improvement in ADHD symptoms after the intervention and in the follow-up period of 3–6 months (Poissant et al., 2019).

Despite these benefits, individuals with ADHD tendency may have difficulty performing static meditation, the most common form of mindfulness training. Inattentiveness makes it difficult to attend to breathing and sensation of body parts. Hyperactivity may make stationary sitting rather a stressful experience. Empirically, Siebelink et al. (2021) reported that ADHD symptoms, such as lack of concentration or the urge to move, create barriers to being mindful. With these characteristics in mind, mindfulness training has been devised specifically for individuals with ADHD tendency.

Zylowska (2012) recommends starting with vigorous exercise or mindful brisk walking to burn energy if stationary sitting is difficult, or an "active body scan" with slight movement of body parts if stationary sitting is not possible during a body scan; a kind of mindfulness meditation. Further, mindful awareness practices (MAPs) developed by Zylowska et al. (2008) are tailored to the characteristics of individuals with ADHD, including walking instead of silent meditation for a shorter-than-usual time. A study using MAPs found the reduced symptoms of inattention and hyperactivity/impulsivity and improved executive functioning (Mitchell et al., 2017). However, when implementing mindfulness in educational settings, where children and adolescents with ADHD and those without ADHD are mixed, it is necessary to facilitate implementation by devising components that are more integrated into meditation, rather than changing the program. This would allow for a universal and inclusive meditation that can be conducted by simply changing some of the components, without the need to separate practices that are specialized for children with ADHD from those that are not. One element that makes this possible is physical posture.

Physical Postures as Facilitators of Mindfulness Practices

Physical posture is emphasized as a factor in mindfulness (Jo, 2019); however, posture has psychological effects independent of mindfulness. This is known as the Jamesian theory of emotion (James, 1890). Riskind and Gotay (1982) compared persistence in a learned helplessness task between individuals who assumed slumped and upright postures and found less persistence in the former. Further, Wilkes et al. (2017) conducted posture manipulation among individuals with mild-to-moderate depression and found that participants who adopted an upright posture had greater arousal levels and positive affect. Furthermore, in educational settings, individuals are more confident of their thoughts when they assume an upright posture (Briñol et al., 2009). Overall, an upright posture has a positive psychological effect, while a slumped posture has a negative impact.

The psychological effects of the supine position have been investigated in the same way as those of the sitting position. Harmon-Jones and Peterson (2009) showed that the supine position, compared to the upright sitting position, reduced anger by decreasing approach motivation. Further, Harmon-Jones et al. (2011) found that participants' desire for food increased in the leaning-forward posture, while in the reclining posture, the response to food was the same as that to non-food items, such as rocks. Harmon-Jones et al. (2013) defined approach motivation as an impulse to move toward an external object, whether positive or negative. By assuming a supine position, individuals' anger and aggressive urges toward surrounding objects may be alleviated, and the generation of desires in them may be suppressed, facilitating their concentration on the practice of body scan.

Traditional mindfulness and meditation practices are taught to be performed in an upright posture (Kabat-Zinn, 1990; Segal et al., 2002). Further, body-scan meditation is performed by individuals assuming supine and sitting positions (Zylowska, 2012). However, few studies have quantitatively examined how the ease of practicing mindfulness differs depending on posture. This study examined the differences in the ease of mindfulness practice between individuals assuming supine and chair positions through body-scan meditations and the differences in the ease of mindfulness practice when the degree of the chair's back extension is changed.

ADHD includes an inattentive type, a hyperactive/impulsive type, and a combined type (which has both inattentive and hyperactive/impulsive characteristics). ADHD tendencies, especially hyperactivity/impulsivity, have delay aversion, which is the desire for immediate reward (Sonuga-Barke, 2002; Thorell, 2007). Given the persistent attitude to tasks, which Riskind & Gotay (1982) indicated, the upright posture may allow people with ADHD tendencies to be able to perform mindfulness meditation from which they cannot feel the effects immediately. Besides, considering that ADHD is the disability of executive function (Hepark et al., 2019) and that mindfulness is the training of attention (van de Weijer-Bergsma et al., 2012), the supine posture, which improves executive attention (Barra et al., 2015), may facilitate mindfulness meditation practices in terms of attention function. Additionally, as the supine posture reduces an impulse to an external object (Harmon-Jones & Peterson, 2009), it may facilitate mindfulness meditation practices by people with impulsivity. Considering these multiple factors, although supine and upright postures may influence the feasibility of mindfulness differently depending on these ADHD types, revealing those differences may provide insights for practitioners with ADHD. Facilitating mindfulness practice through posture will lead to personalized care through an understanding of the diverse needs of individuals with ADHD tendency whose practice is hampered by inattention, hyperactivity, and impulsivity.

The Present Study

To date, the feasibility of mindfulness exercises has been assessed by dropout rates (Gu et al., 2018; Janssen et al., 2018), feedback (Edel et al., 2017), and self-reporting (Montanari et al., 2019). No quantitative measures exist for feasibility. Some studies have examined why individuals initiate and continue mindfulness exercises (Pepping et al., 2016) and their perceived benefits and doubts (Sears et al., 2011). Developing scales that measure the feasibility of mindfulness will enable us to know the extent of feasibility of mindfulness practices quantitatively and compare feasibility among the methods and program, and contribute to selecting the appropriate approach to practice for individuals. In actual mindfulness practices, negative reactions do not always lead to immediate dropout, as some aspects can be handled individually by therapists and facilitators. However, the development of the scale to assess such reactions easily may make it easier to utilize them in practice. Still, responses have been categorized only, and not used for developing scales. The feasibility of performing mindfulness exercises can be thought of as responses encouraging or discouraging the practice or continuing the exercise. Thus, a scale that measures responses that occur within the individual to either encourage or discourage practice through mindfulness practice reflects the feasibility of this engagement.

Therefore, this study is based on the following research objectives: (a) to develop the Mindfulness Encouraging Reactions Scale (MERS) and the Mindfulness Discouraging Reactions Scale (MDRS) and (b) to examine whether there are differences in encouraging or discouraging responses to the body-scan meditation depending on body posture, including the postures of participants with ADHD tendencies. The reason for focusing on body-scan meditation in this study is that although Kabat-Zinn (1990) recommended practicing body-scan meditation in the early stage for beginners, the classroom environment often forces the practice of sitting on a chair, and the relationship between body scan and postures has not been examined. Characteristics of inattention and hyperactive/impulsive traits of ADHD are considered to form a spectrum (Okano et al., 2004). Also a taxometric analysis concludes ADHD as a continuum (Haslam et al., 2006). Furthermore, some students are aware of their inattention or hyperactive/impulsive traits, regardless of the presence or absence of diagnosis (Shinoda et al., 2015). In any event, considering the increasing number of students with ADHD (Japan Student Services Organization, 2023), research is required to capture a continuum of ADHD characteristics of the general student population, rather than using cutoff points. In addition, information about diagnosis is considered to be a personal and confidential matter to be protected. Therefore, we did not ask about the presence or absence of a diagnosis and did not include a clinical group, but defined "people with ADHD tendency" as those with high ADHD characteristics based on the mean score of an ADHD screening test, and compared them with "people without ADHD tendency."

For research objective (a), we conducted a survey to collect typical positive and negative reactions during mindfulness exercises to create the preliminary items in Study 1, and verified the reliability and validity of developed MERS and MDRS in Study 2. For research objective (b), we examined the differences in encouraging or discouraging responses to the body-scan meditation between postures and tendencies of ADHD in Study 3. Based on previous studies and conventional instructional methods, we hypothesized that the supine and upright postures would facilitate the body-scan meditation; that slumped posture would be unsuitable for them; that the leaning-back posture would yield neutral outcomes; and that these effects of the postures would be more pronounced in those with higher ADHD tendencies than in those with lower ones, since general participants do not inherently find body scan particularly challenging. We also expected that because of the different nature of inattention and hyperactivity/impulsive tendencies, there would be differences or reversals in the effects of posture. Although there are almost no previous studies that have examined the intra-personal effect of physical posture for people with ADHD, the mechanisms of ADHD and embodied cognition are supposed to be independent. Therefore, manipulations of posture affect mental aspects, regardless of the presence or absence of ADHD.

Study 1

Method

Participants. Since this was an intervention study and was conducted under the coronavirus 19 (COVID-19) restrictions, 21 university students were included in this study, while the sample size was planned to be 60 participants, based on similar previous studies (Sears et al., 2011). The participants were selected based on the exclusion criteria described in the Procedure section below.

Instructions for mindfulness exercises. Five mindfulness exercises were used: (a) eating meditation, (b) sitting meditation,

(c) yoga meditation, (d) walking meditation, and (e) body-scanning meditation. All of these practices were introduced by Kabat-Zinn (1990) as MBSR techniques. The instructions were adapted from previous studies (May et al., 2010), mindfulness guidebooks (Kabat-Zinn, 2002), and instructions available on the Internet (Bertin, 2017; University of New Hampshire Health & Wellness, 2011), while keeping the narrative as plain as possible. Eating, sitting, and walking meditation and the body-scan meditation were presented in audio format, narrated by the first author. Yoga meditation was presented in a video/audio form, narrated by the first author with illustrations of the poses (Kabat-Zinn, 1990). The audio and video recordings were approximately 10 min long. Since a lot of guide instructions assume that practitioners meditate themselves, using instructions, audio files, and illustrations (Kabat-Zinn, 1990, 2002), the participants were supposed to be able to practice mindfulness using only audio and visual files. Furthermore, some previous studies conducted meditation interventions online, without instructors beside the participants (Osin & Turilina, 2022). Although yoga and walking meditations were dynamic, they did not require a large space and participants were informed that it was possible to practice them in a relatively small room. Because of time constraints, participants practiced three of the five specified meditation practices. The three meditation practices were counterbalanced to assign participants in the order they contacted the first author to one of 10 patterns, so that the number of data for each meditation was as equal as possible.

Questionnaire. We used the preliminary MDRS and MERS created using Google Forms. The MDRS contained eight questions, referring to previous research on factors that reduced commitment to various activities, such as club activities and studying (Inaji & Shenda, 1992). Regarding the time taken for meditation, a sample item is, "What can be improved? And specify reasons." The participants answered in a descriptive form. The preliminary MERS was designed with definitions of the four motivational categories of external, introjected, identified, and integrated regulations, as described in self-determination theory (Ryan & Deci, 2000) and previous studies based on these definitions (Okada, 2005; Toyama & Tang, 2019). The questionnaire consisted of two items for each of the four motivational categories in mindfulness practice; thus, the participants were asked eight questions based on each mindfulness practice. For example, after the statement, "The reason why I could continue doing ____ (name of meditation practice) is that I wanted to do ____ myself," there were five options (1: *nothing*, 2: *a little*, 3: *some*, 4: *quite a lot*, 5: *a lot*), and the participants were asked to select the one that suited them. In response to this question, if the participant chose an option other than "1: *nothing*," a descriptive question seeking specific details was presented. Finally, the participants provided demographic information.

Procedure. The third author supervised the procedures. This entailed creating instructions for meditation, determining the exclusion criteria, and the measures against risks, and the first author recorded audio instruction and kept in contact with the participants. The third author is a licensed clinical psychologist in Japan and has been supervised in meditative techniques, including mindfulness, consistently since 1996, and has held such workshops for students, the general public, and clinical experts regularly for more than 15 years. In addition, in case of emergency, the third author was on standby to deal with the participants. During the psychology class, the first author distributed a recruitment form that included information on the purpose of this study (to research the points to be improved for mindfulness practice), an overview of mindfulness, the exclusion criteria, and rewards for participation. Those who completed the application form or contacted the first author through a designated messaging application were considered potential participants. The exclusion criteria included: (a) receiving treatment for mental health problems, (b) visiting internal medicine or orthopedic doctors, and (c) having difficulty stretching or balancing their body. These exclusion criteria are regarded as reasonable, given the potential risk of the adverse effects of mindfulness on some individuals (Lustyk et al., 2009). Those with mental and physical illnesses, except those with the targeted disorder, are commonly excluded in mindfulness research (Edel et al., 2017; Gu et al., 2018; Mitchell et al., 2017). Further, a guidebook on mindfulness (Kabat-Zinn, 2002) stated that individuals with medical or orthopedic illnesses should consult a doctor before practicing yoga. Moreover, as Lustyk et al. (2009) recommended, the background of mindfulness should be explained to individuals and their religious views should be considered. Thus, at the time of recruitment, we also clarified to the participants that mindfulness is considered to be devoid of religious components, and that the meditation involved therein has no mystical connotations.

The remainder of the procedure was conducted online because of the COVID-19 pandemic. The students were sent a consent form describing the purpose of the study, precautions, and data handling. They received an online pamphlet containing instructions on the three meditation practices. After providing informed consent, the participants meditated and completed the questionnaire, at their convenience, over a period of 5 days. They accessed guided audio and video meditation practices through a link at the beginning of the questionnaire. Each time the participants completed a meditation practice, they were asked if they could finish it; thereafter they completed a preliminary MDRS. At the end of the 5-day program, the participants completed a preliminary MERS for the three meditation practices and were interviewed, orally, for up to 2 hr. Interviews were used to clarify the intent of the input responses, with the first author asking for specifics based on the answers to the questionnaire, and whether the participant noticed any other points. After finishing the survey, the participants were sent an honorarium of 1,000 yen for every hour of their participation. All procedures used in this study were approved by the Ethical Committee of the affiliation of the first author (Approved number: 150).

Results and Discussion

Fifteen participants (two men, 12 women, and one unknown gender) were assigned to the eating-meditation group. Of these, four were excluded because of incomplete responses and 11 responses (two men, nine women, $M_{age} = 18.00$ years, $SD = 0.49$ years) were included in the analyses. Thirteen participants were assigned to the sitting-meditation group. All were included in the analysis (three men, 10 women; $M_{age} = 18.46$ years, $SD = 0.52$ years). Eleven participants were assigned to yoga meditation, and all were included in the analysis (one man, 10 women, $M_{age} = 18.55$ years, $SD = 0.52$ years). Twelve participants were assigned to the walking-meditation group; one was excluded owing to an incomplete response. Only 11 responses (three men, eight women, $M_{age} = 18.64$ years, $SD = 0.50$ years) were included in the analysis. Thirteen participants were assigned to the body-scan meditation group and were included in the analysis (three men, 10 women; $M_{age} = 18.46$ years, $SD = 0.52$ years). Although only one participant could not complete walking meditation for one trial, we did not distinguish whether they completed or stopped the meditations. The purpose of this study was collecting subjective reports of the experiences of mindfulness practices.

The first author summarized the descriptions of the difficulty and ease of performing meditation practices in the following manner, and the third author checked the results from the following viewpoints: whether items of MDRS reflect the responses to mindfulness teachers' instructions to refocus attention; whether they contain response instruction guides (Kabat-Zinn, 2002; Teasdale et al. 2014) for when participants' attention was distracted; and whether items of MERS are applicable to positive affectivity, since mindfulness increases awareness to positive affectivity (Lindsay et al., 2018).

First, for each meditation type, those with no content, such as "nothing special," were eliminated, and the main points of the remaining sentences were concisely paraphrased. A sentence with multiple meanings was divided into short sentences in this process. Next, paraphrased short sentences were sorted into similar sentences, regardless of the question. Duplicates were deleted, and virtually identical responses were combined. The first and third authors then labeled each of the sorted short sentences according to the content to which they referred and distinguished them as either meditation-specific or common to each meditation. After the above procedure was completed for the descriptions of each meditation type, these descriptions were unified, duplicates were removed and the labels were subdivided. Further, the content that applied only to each meditation type was removed, and item wording was created for each label regarding the short texts. Finally, from the description of adverse reactions, the first and third authors deleted factors related to the instructions and the time taken to deliver them, considering that the instructions and materials varied, depending on the place of practice. Based on the above procedures and subsequent examination of the wording, the first and third authors developed 20 preliminary items for the MDRS (Table 1) and 29 for the MERS (Table 2). Items created were consistent with perceived benefits and doubts of mindfulness (Sears et al., 2011), reasons for initiating or continuing mindfulness training (Pepping et al., 2016), and daily experiences during meditation in a sample of novice practitioners (Osin & Turilina, 2022), which would involve adequate content validity.

Table 1
Preliminary items for the Mindfulness Discouraging Reactions Scale

1	I felt irritated.
2	I felt nervous about what the people around me would think.
3	I felt monotonous.
4	I felt like I wanted to do something different instead of staying in the same position.
5	I felt that the goal was hard to grasp.
6	I felt it was not interesting.
7	I felt it was not fun.
8	I felt it was difficult to pay attention to my breathing.
9	I felt bored.
10	I felt it was difficult to maintain the same posture.
11	I felt it was hard to feel the benefits.
12	I felt it was hard on my body.
13	I felt like a bother.
14	I felt no sense of achievement.
15	I felt uneasy about whether I was doing it right.
16	I felt sleepy.
17	I felt like my surroundings were a little noisy.
18	I felt like I would get bored.
19	I felt like I could not concentrate.
20	I felt like I was having a hard time paying attention.

Study 2

We developed the MDRS and MERS based on the items identified in Study 1. This study referred to item response theory (IRT), which provides more precise information than traditional methods regarding scales and items based on the classical test theory. To measure construct validity, we also examined a possible difference in responses to the MDRS and MERS between those who could complete mindfulness meditation and those who stopped it midway. Further, we confirmed correlations with existing scales that measure the degree of mindfulness as a measure of concurrent validity.

Method

Participants. A total of 273 university students, from two introductory psychology classes, participated in this study, in contrast to Study 1. The sample size was based on similar previous studies (Lau et al., 2006). Only one student (0.005%) had experience with daily mindfulness practice.

Questionnaire. The questionnaire was created using Google Forms and included (a) the Toronto Mindfulness Scale Japanese version (TMS-J; Sugamura & Yamamoto, 2014a, 2014b) (0–4 Likert scale); (b) the Japanese version of the Five Facet Mindfulness Questionnaire (FFMQ-J; Sugiura et al., 2012) (1–5 Likert scale); (c) the Japanese version of the

Mindful Attention Awareness Scale (MAAS; Fujino et al., 2015) (1–6 Likert scale); and (d) the MDRS and MERS items developed in Study 1 (1: *nothing*, 2: *a little*, 3: *some*, 4: *quite a lot*, 5: *a lot*). All scales for confirmation of validity had adequate reliability and validity. At the beginning of the questionnaire, the participants were asked whether they abandoned the meditation practice in the middle, since they were told that they could do so as an ethical consideration. This was followed by the scales and items from (a) to (d). Finally, the demographic questions, the experience of meditation (1: *never*, 2: *only a few times in class*, 3: *regularly*, 4: *almost every day*), and descriptive questions about the physical and mental changes that occurred through meditation were asked. The last descriptive question was a check to determine if the participants had answered the questionnaire thoughtfully.

Instructions for mindfulness meditation. We used a 5-min version of the "Timed Sessions" of the "The Mindfulness App" (MindApps). The audio was recorded in Japanese.

Procedure. The third author supervised the procedures in the same manner as Study 1 and was on standby to deal with the participants in case of emergency. The survey was conducted during lectures in a university; however, as part of COVID-19 prevention, some participants viewed the online content from home, at their convenience. Therefore, the content was made available to the participants for viewing for 2 weeks. In the face-to-face class for approximately 40 students, the first author explained, orally and with slides, the purpose of the study (to research how people feel and think through a mindfulness practice), the same background details regarding mindfulness, and the precautions for risk avoidance and data handling, as described in Study 1. Participatns were also told that participation was not mandatory, would not influence academic results, and that their agreement with the details of the study was required. Afterward, participants practiced meditation while listening to the audio. Additionally, they answered the questionnaire on Google Forms, using their smartphones. No rewards were provided. During the on-demand online class for more than 200 students, the first author provided the participants with a video/audio and a slideshow, and followed the same procedure. After the same details were explained through the video, the first author played the meditation audio, in which instructions to meditate in a quiet and calm environment were included.

Table 2
Preliminary Items for the Mindfulness Encouraging Reactions Scale

1	I felt less stressed overall.
2	I felt like I was starting to get interested in new things.
3	I felt a sense of confidence that I could work on something new.
4	I felt more stable.
5	I felt like I found value in new challenges.
6	I felt like I was savoring the time without being caught up in other things.
7	I felt like I could train myself.
8	I felt like my mind was relaxed.
9	I thought this practice was important for my mental health.
10	I felt like my body was relaxed.
11	I felt like I became more creative.
12	I felt like I was aware of the state of my body.
13	I felt like I could see my life in a new light.
14	I felt that it was important to take time to calm my mind.
15	I felt like my mind was clearer.
16	I felt the value in even the shortest of practices.
17	I felt calmer.
18	I felt the value of making time to face myself.
19	I felt better.
20	I felt that I would benefit in some way.
21	I felt a sense of achievement.
22	I felt that I would be evaluated favorably by the people around me.
23	I thought it would lead to increased income in the future.
24	I thought this practice was important for my physical health.
25	I felt like I was having fun.
26	I felt more confident that I could concentrate.
27	I felt like I could concentrate better.
28	I felt the value of paying attention to myself.
29	I thought that hard work would lead to success in my future.

Finally, the participants responded to the questionnaire using the Google Forms they could access, through the QR code on the slide in the presentation or through the URL provided on the page that contained the video. It is wholly necessary to examine the feasibility of mindfulness practices with respect to long-term programs; however, previous studies have reported that participants abandoned practices after the first session of a long-term program (Zylowska et al., 2008) and many participants dropped out of even short-term programs (Forbes et al., 2018). Therefore, this study focused on the feasibility of a one-off mindfulness practice, as it also has an important role. All procedures used in this study were approved by the Ethical Committee of the affiliation of the first author (Approved number: 172).

Statistical analyses. First, exploratory factor analysis using the principal factor method was used to confirm the assumption of one-dimensionality of the IRT. Then, analysis based on the IRT was conducted using Expected A Posteriori for estimation and the generalized partial credit model (GPCM; Muraki, 1992), a Polytomous IRT Model. Finally, PARSCALE 4.1 (Muraki & Bock, 2003) was used to estimate the parameters. The GPCM can estimate category parameters consistently on a scale that is thought to be suitable for Likert-style data.

To confirm construct validity, we compared the IRT's test information content $I(\theta)$ for participants who completed the meditation practice to those who did not, using unpaired *t*-tests for the MDRS and MERS. In addition, Pearson's correlation coefficients between the θ of the MDRS and MERS and the TMS-J, the Japanese version of the MAAS, and the FFMQ-J were calculated to confirm concurrent validity. It is known that θ is highly correlated with the prime scores. SPSS Statistics 27 (IBM Corp., Armonk, NY, USA) was used for all analyses.

Results

A total of 192 participants (78 men, 114 women, $M_{age} = 18.91$ years, $SD = 1.19$ years) were included in the analyses, excluding 79 participants with missing values for MDRS, FFMQ, MAAS, and demographic information, who answered only one of the two separate forms, and two participants with the same responses to all scale items. There was no bias regarding whether or not participants completed the meditation ($\chi^2 = 0.07$, $p = .79$), had scores for TMS-J (curiosity: $t = 0.18$, $df = 271$, $p = .86$; decentering: $t = 0.50$, $df = 271$, $p = .62$), and had scores for MERS ($t = 0.59$, $df = 271$, $p = .55$) between participants excluded and those included in the analysis.

For the 20 items of the MDRS, the contribution ratio of the first factor was 34.34% (eigenvalue 6.87); that of the second factor was 9.44% (eigenvalue 1.89); and that of the third factor was 8.38% (eigenvalue 1.68), confirming a one-factor structure because of the high contribution ratio of the first factor and the drop in eigenvalues. Factor analysis was conducted again with this structure, and items whose factor loading was below at least .40 were deleted. After deleting "I felt nervous about what the people around me would think," "I felt sleepy," "I felt like my surroundings were a little noisy," "I felt it was difficult to pay attention to my breathing," "I felt it was hard on my body," "I felt like I was having a hard time paying attention," and "I felt uneasy about whether I was doing it right," no items remained with factor loadings below 0.4. Therefore, the remaining 13 items were adopted. We estimated the item parameters based on the GPCM (Table 3). The maximum amount of test information, which represents the accuracy of the measurement, was 18.8 ($\theta = 0.14$), and the range of θ over 9 (estimated value corresponding to a sufficient reliability coefficient[1]) was −1.52 to 1.79. Cronbach's alpha was .88.

For the 29 MERS items, the contribution ratio of the first factor was 42.57% (eigenvalue 12.35), that of the second factor was 9.03% (eigenvalue 2.62), and that of the third factor was 4.81% (eigenvalue 1.40), confirming a one-factor structure because of the high contribution ratio of the first factor and the drop in eigenvalues. Factor analysis was conducted

Table 3
Estimated item parameters of the Mindfulness Discouraging Reactions Scale

Item	Slope	(*SE*)	Location	(*SE*)
I felt irritated.	0.29	(0.06)	2.08	(0.27)
I felt it was monotonous.	0.45	(0.06)	−0.11	(0.10)
I felt like I wanted to do something different instead of staying in the same position.	0.31	(0.05)	0.15	(0.13)
I felt that the goal was hard to grasp.	0.62	(0.08)	−0.22	(0.08)
I felt it was not interesting.	1.52	(0.16)	0.2	(0.05)
I felt it was not fun.	1.39	(0.15)	0.08	(0.05)
I felt bored.	1.31	(0.14)	0.23	(0.05)
I felt it was difficult to maintain the same posture.	0.24	(0.04)	0.28	(0.16)
I felt it was hard to feel the benefits.	0.67	(0.08)	0.25	(0.07)
I felt it was a bother.	0.83	(0.10)	0.16	(0.07)
I felt no sense of achievement.	0.57	(0.07)	0.06	(0.08)
I felt like I would get bored.	0.97	(0.11)	0.09	(0.06)
I felt like I could not concentrate.	0.54	(0.07)	0.42	(0.09)
	Category	2	1.55	(0.06)
		3	0.29	(0.04)
		4	−0.16	(0.04)
		5	−1.68	(0.07)

Note. The items employed in the scale only describe the novice's response to mindfulness, not necessarily the correct conception of mindfulness.

again using this confirmed structure. After deleting "I felt like I was aware of the state of my body," "I thought that hard work would lead to success in my future," "I felt like I was starting to get interested in new things," and "I thought it would lead to increased income in the future," no items remained with factor loadings below 0.5. Therefore, the remaining 25 items were adopted. We estimated the item parameters based on the GPCM (Table 4). The maximum amount of test information, which represents the accuracy of the measurement, was 27.2 ($\theta = -0.69$), and the range of θ over 9 (estimated value corresponding to a sufficient reliability coefficient) was –2.90 to 2.34. Cronbach' s alpha was .95.

Validation. A total of 144 participants completed the meditation practice and 48 stopped midway. The results of the *t*-test showed that the θ of the MDRS was lower in participants who completed the meditation practice ($M = -0.20$, $SD = 0.94$) than in those who stopped ($M = 0.38$, $SD = 0.63$, $t\ (120.63) = 4.80$, $p < .001$, $g = 0.66$, 95% CI $_{\text{mean difference}}$ [0.34, 0.82]). The θ of the MERS was higher for participants who completed the meditation practice ($M = 0.19$, $SD = 0.96$) than for those who did not ($M = -0.50$, $SD = 0.86$, $t\ (190) = 4.43$, $p < .001$, $g = 0.74$, 95% CI $_{\text{mean difference}}$ [0.38, 0.99]).

The correlations of the MDRS and MERS with existing mindfulness scales are shown in Table 5. The MDRS showed weak negative correlations with the Curiosity ($r = -.33$, $p < .001$, 95% CI [–0.45, –0.20]) and Decentering ($r = -.48$, $p < .001$, 95% CI [–0.58, –0.36]) subscales of the TMS-J. The MERS was moderately positively correlated with the Curiosity ($r = .59$, $p < .001$, 95% CI [0.49, 0.68]) and Decentering ($r = .64$, $p < .001$, 95% CI [0.55, 0.72]) subscales of the TMS-J.

Discussion

In this study, item parameters based on the IRT model were obtained. For the MDRS, the slope parameter was low, but the amount of test information affected by it covered approximately

Table 4
Estimated item parameters of the Mindfulness Encouraging Reactions Scale

Item	Slope	(*SE*)	Location	(*SE*)
I felt less stressed overall.	0.7	(0.08)	−0.14	(0.08)
I felt a sense of confidence that I could work on something new.	0.5	(0.07)	0.75	(0.10)
I felt more stable.	0.97	(0.10)	−0.79	(0.07)
I felt like I found value in new challenges.	0.54	(0.07)	0.8	(0.09)
I felt like I was savoring the time without being caught up in other things.	0.55	(0.07)	−0.86	(0.10)
I felt like I could train myself.	0.72	(0.08)	0.39	(0.07)
I felt like my mind was relaxed.	0.73	(0.09)	−1.31	(0.09)
I thought this practice was important for my mental health.	0.82	(0.09)	−0.44	(0.07)
I felt like my body was relaxed.	0.78	(0.09)	−1.07	(0.08)
I felt like I became more creative.	0.53	(0.07)	1	(0.10)
I felt like I could see my life in a new light.	0.49	(0.07)	0.6	(0.09)
I felt that it was important to take time to calm my mind.	0.74	(0.09)	−1.62	(0.10)
I felt like my mind was clearer.	0.6	(0.07)	0	(0.08)
I felt the value in even the shortest of practices.	0.72	(0.08)	−0.55	(0.08)
I felt calmer.	0.77	(0.09)	−1.24	(0.09)
I felt the value of making time to face myself.	0.71	(0.08)	−0.75	(0.08)
I felt better.	1.07	(0.11)	−0.27	(0.06)
I felt that I would benefit in some way.	1.19	(0.12)	−0.18	(0.06)
I felt a sense of achievement.	0.62	(0.07)	0.21	(0.08)
I felt that I would be evaluated favorably by the people around me.	0.47	(0.07)	1.4	(0.12)
I thought this practice was important for my physical health.	0.64	(0.07)	−0.38	(0.08)
I felt like I was having fun.	0.45	(0.06)	0.35	(0.10)
I felt more confident that I could concentrate.	0.79	(0.09)	0.56	(0.07)
I felt like I could concentrate better.	0.89	(0.10)	−0.13	(0.07)
I felt the value of paying attention to myself.	0.7	(0.08)	−0.19	(0.08)
	Category	2	1.54	(0.05)
		3	0.51	(0.04)
		4	0	(0.03)
		5	−2.04	(0.04)

Note. The items employed in the scale only describe the novice's response to mindfulness, not necessarily the correct conception of mindfulness.

90% (the rate of –1.52 to 1.79 in a standard normal distribution) of the responses on a scale of 9.[1] The location parameter was slightly biased toward the positive. Therefore, the hypothesis that it measures the negative response of difficulty performing mindfulness tasks is reasonable. For the MERS, we used some items with low slope parameters, but when we focused on the range of test information over 9, we could measure almost all responses, with high accuracy for 96% (the rate of –2.90 to 2.34 in a standard normal distribution) of them.

Focusing on the location parameter, in the MDRS, items related to motivation, such as "I felt no sense of achievement," were clustered from −0.5 to 0, and items related to difficulty during practice, such as "I felt bored," were

[1]The relationship between θ and standard error is s.e. $= \sqrt{1/\theta}$. The relationship between true reliability coefficient in classical test theory (ρ) and standard error is s.e. $= \sqrt{1\text{-}\rho}$ if they are standardized. In comparison, between θ and reliability coefficient using those formulae, $\rho = 0.8$ corresponds $\theta = 5$, $\rho = 0.9$ corresponds $\theta = 10$. Given $\rho \geqq$ Cronbach's α, we adopted 9 instead of 10, conservatively. This method was adopted in a previous study (Namikawa et al., 2012).

Table 5
Correlations between mindfulness-related scales and the Mindfulness Discouraging Reactions Scale and Mindfulness Encouraging Reactions Scale

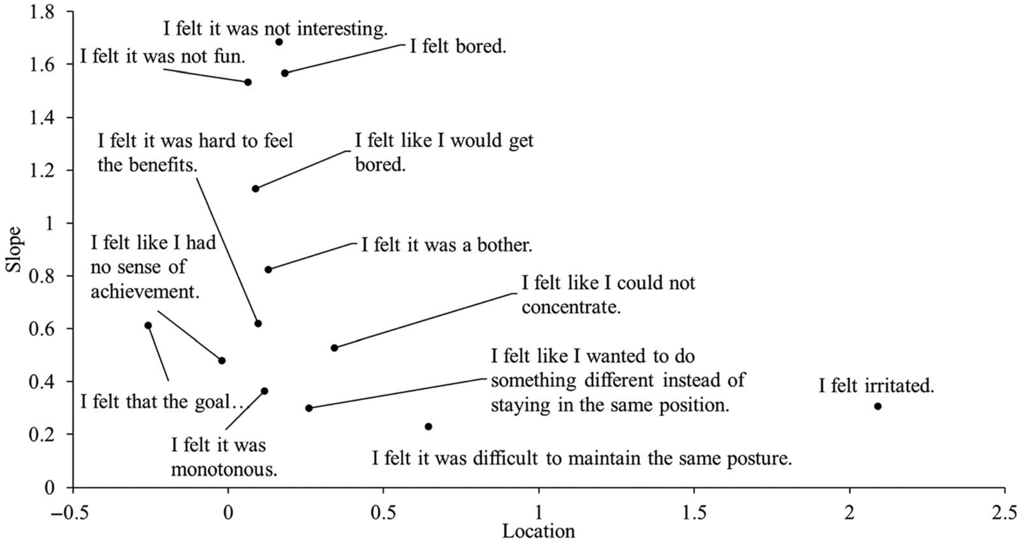
	MDRS	MERS
TMS-J		
Curiosity	−.328**	.591**
Decentering	−.482**	.641**
MAAS	.054	.056
FFMQ-J		
Observing	−.050	.034
Describing	−.051	−.001
Acting with Awareness	−.036	−.027
Non-judging	−.013	−.014
Non-reactivity	−.004	.050

Note. FFMQ-J = Five Facet Mindfulness Questionnaire Japanese version; MAAS = Mindful Attention Awareness Scale; MDRS = Mindfulness Discouraging Reactions Scale; MERS: Mindfulness Encouraging Reactions Scale; TMS-J = Toronto Mindfulness Scale Japanese version.
** $p < .01$.

clustered from 0 to 1.0 (Figure 1). This result may mean that those with relatively mild negative reactions to mindfulness practice may experience difficulty maintaining motivation. Contrastingly, those with strong negative reactions may experience trouble during practice. For example, the item "I felt irritated," with a location parameter greater than 2.0, may indicate individuals' greater tendency to negative reactions toward mindfulness practice. In the MERS, items related to immediate effects, such as "I felt like my mind was relaxed," were clustered from −2.0 to 0. Items pertaining to short or medium-term impact, such as "I felt like I could train myself," were clustered from 0 to 1.0. Items related to experiences that extended beyond the practice itself, such as "I felt a sense of confidence that I could work on something new," were clustered from 1.0 to 2.0 (Figure 2). This pattern suggests that those who may not experience positive reactions to mindfulness practice feel short-term effects from the practice. Contrastingly, those who may experience positive reactions to mindfulness practice can experience benefits beyond the practice itself.

For validation, those who completed the meditation practice rated their unfavorable reactions to meditation lower and their favorable responses higher than those who stopped it midway. When we consider that the ease or difficulty of performing meditation practice

Figure 1
Location and slope parameters of the Mindfulness Discouraging Reactions Scale items.



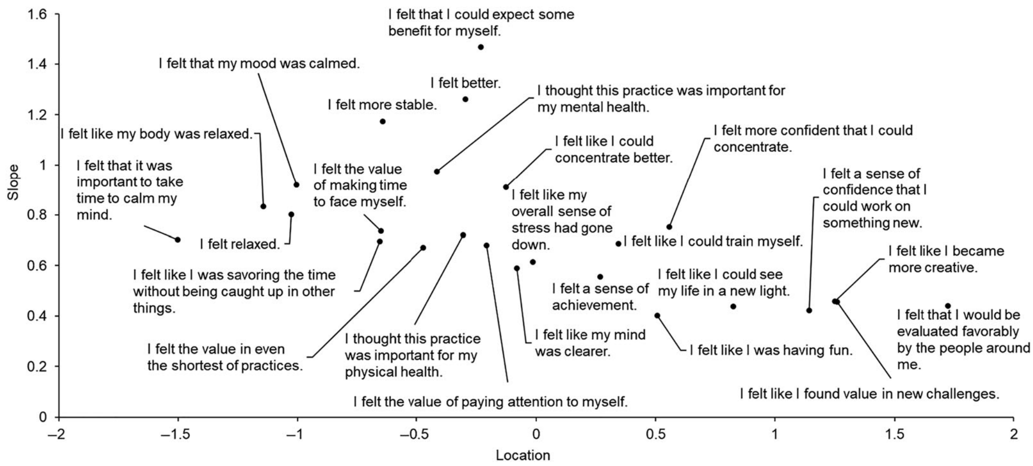
influences its completion, this result indicates sufficient construct validity. The MDRS and MERS were correlated with the TMS-J but not with the MAAS or FFMQ in terms of concurrent validity.

This result may reflect that the Japanese versions of the MAAS and the FFMQ-J focus on trait mindfulness (individuals' predisposition to be mindful daily), whereas the TMS-J focuses on state mindfulness (mindfulness that occurs to individuals when they meditate). Since the MDRS and MERS, like the TMS-J, assess the state during a single point in time (Lau et al., 2006) and inquire into previous meditation experiences, a correlation might be expected. Reasonably, those who experienced less difficulty performing meditation and felt more at ease in performing meditation rated state mindfulness higher. Initially, we expected that trait mindfulness would also show a correlation to MDRS and MERS. However, considering that TMS does not correlate with MAAS (Thompson & Waltz, 2007) and correlates with only limited factors of FFMQ (Siegling & Petrides, 2016), it is reasonable that MDRS and MERS with similar aspects to TMS did not correlate with MAAS and FFMQ. In particular, in the context of the findings of the present study, while people with high trait mindfulness carry out the practices and feel the efficacy, it is also possible that they rarely perceive efficacy because they are usually mindful. Similarly, while people with low trait mindfulness may experience difficulty in following the instructions and feel efficacy, it is also possible that they perceive efficacy easily because they become more mindful than usual through the experience of the practice. Therefore, it was difficult to assume a simple linear relationship between trait mindfulness and these other measures, which may have been reflected in the lack of correlations. Note that the two scales created are based solely on intuitive impressions for beginners, and do not indicate whether the practices are done well or recommend that the items included in them be aimed for or avoided.

Study 3

Using the MDRS and MERS developed in Study 2, we examined which postures facilitated body-scan meditation and how differences in postures varied across ADHD tendencies. In addition, considering that body-scan meditation induces sleepiness (Baer & Jennifer, 2015) and some people actually fall asleep during meditation (Kabat-Zinn, 1990), we also

Figure 2
Location and slope parameters of the Mindfulness Encouraging Reactions Scale items.



examined whether sleepiness correlates with the feasibility of body-scan meditation.

Method

Participants. In a psychology class, 110 students (29 men, 76 women, five unknown gender) agreed to participate in the study and answered the Adult ADHD Self-Report Scale (A-ADHD; Fukunishi, 2016; 1–4 Likert Scale). The sample size was planned to be 25–30 participants per group, based on similar previous studies (Wilkes et al., 2017) and power analysis (Murai & Hashimoto, 2018). However, after we excluded those who did not meet the criteria, in the same way as Study 1 and 2, besides grouping criteria according to A-ADHD (as described below), 19 students (two men, 17 women, $M_{age} = 18.26$ years, $SD = 0.56$ years) participated in the experiment in total.

Questionnaire. We used the A-ADHD consisting of 35 items on a four-point Likert scale to screen for the tendencies of inattention and hyperactivity/impulsivity. In this scale, the maximum scores of inattention and hyperactive/impulsive tendencies were 56 and 24, respectively. In the experiment, we used a questionnaire created on Google Forms, including (a) the TMS-J (Sugamura & Yamamoto, 2014a, 2014b), (b) the MDRS and MERS developed in Study 2, (c) sleepiness measured using the Online-Based Visual Analogue Scale (O-VAS; Fukuichi & Sugamura, 2021), and (d) sleepiness measured using the Japanese version of the Karolinska Sleepiness Scale (KSS-J; Kaida et al., 2006) (1–9 Likert Scale). The participants responded to items (a) and (b) after the body-scan meditation, and to items (c) and (d) before and after the meditation.

Instructions for mindfulness exercise. We used the same instructions as in Study 1. However, the posture instructions were modified to fit the conditions for Study 3. In the upright-posture condition, the instruction to stay upright was given several times.

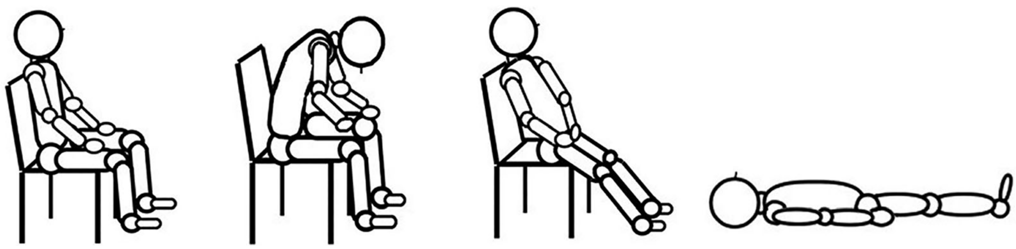
Procedure. The third author supervised the procedures in the same manner as in Studies 1 and 2 and was on standby to deal with the participants in case of emergency. The screening was performed in a large classroom. The experiment was conducted at home on convenient days and times, other than immediately after the participants ate or exercised, as a pandemic precautionary measure. During the screening survey, the purpose (to research the relationship between mindfulness meditation and body postures) and content of the study, a brief description of mindfulness, and data handling were explained to the participants orally and by using slides. The participants were then guided to Google Forms. If they agreed to participate, they were instructed to provide their name and contact information so that the first author could contact them later. They were asked to complete a risk-avoidance checklist. This checklist consisted of three items about PTSD symptoms and 10 items about other mental symptoms, such as dissociation in reference to the GRID-HAMD structured interview guide (Japanese Society of Clinical Neuropsychopharmacology, 2003), Dissociative Experiences Scale (Putnam, 1997/2001), and the screening questionnaire of PTSD by Dobkin et al. (2012). After completing the application form, the participants answered the A-ADHD questionnaire on the spot.

According to their A-ADHD scores, the participants who belonged to one of the four types were selected: (a) combined type tendency with both inattention and hyperactivity/impulsivity scores of mean + 1 SD and more (inattention: $M = 38.75$, $SD = 3.40$; hyperactive/impulsive: $M = 14.00$, $SD = 3.56$); (b) inattentive type tendency with inattention scores of mean + 1 SD and more and hyperactivity/impulsivity scores of less than mean + 1 SD (inattention: $M = 39.50$, $SD = 6.36$; hyperactive/impulsive: $M = 11.00$, $SD = 1.41$); (c) hyperactivity/impulsivity type tendency with inattention scores of less than mean + 1 SD and hyperactivity/impulsivity scores of mean + 1 SD and more (inattention: $M = 29.00$, $SD = 3.00$; hyperactive/impulsive: $M = 13.80$, $SD = 1.92$); and (d) without ADHD tendency with inattention scores of mean – 1 *SD* and below and hyperactivity/impulsivity scores of mean – 0.75 *SD* and below (– 1 *SD* would have resulted in zero participants) (inattention: $M = 18.50$, $SD = 1.64$; hyperactive/impulsive: $M = 6.83$, $SD = 0.98$). The one-way ANOVA with group variable revealed that the mean scores of inattention in combined or inattentive groups and that of hyperactivity/impulsivity in combined or hyperactive/impulsive groups were higher than in the group without ADHD ($ps < .002$). Adding that the cutoff point of inattention is 38–41 (Fukunishi, 2016), it was confirmed that the allocation was appropriate. Some previous studies assigned participants to relatively high or low ADHD groups, not using the diagnosis criteria or the cutoff point but according to the mean of the ADHD scale and interpreted the high ADHD group as people with substantially high ADHD tendencies, similar to this study (Nakano & Okazaki, 2019). Of the 38 participants selected, 19 responded to the invitation to participate. In this experiment, the participants performed the bodyscan meditation in upright, slumped, leaning-back, and supine postures (Figure 3) on a convenient day and answered a questionnaire before and after each meditation practice.

The posture-related instructions were provided with text only or with pictures and text. The instructions with the illustration for the upright posture were, "Put your feet flat on the floor directly below your knees. Rest your hands on your lap. Straighten your spine. Do not lean on the backrest. Look forward." The instruction with the illustration for the slumped posture was, "Put your feet flat on the floor directly below your knees. Bend your back and drop your head downward with your face. Rest your hands in your lap." The instruction with the illustration for the leaning-back posture was "Sit toward the edge of your chair and lean back, being careful not to fall backward. Your face should look upward. Extend your legs as if you were throwing them forward. Place your hands at the base of your thighs." The instruction for the supine posture was, "Lie on your back on a carpet, thick rug, or bed. Place your arms beside your body, palms facing the ceiling, and feet slightly apart." The posture order was counterbalanced. All procedures used in this study were approved by the Ethical Committee of the affiliation of the first author (Approved number: 179).

Statistical analyses. The amount of test information $I(\theta)$ of IRT, calculated in the same way as Study 2, and two factors of the TMS-J were analyzed using a two-way analysis of variance with a within-subjects posture variable (upright, slumped, leaning back, and supine) and a between-subjects variable of ADHD tendency (combined, inattentive, hyperactive/impulsive, and without ADHD tendency). A Bonferroni post-hoc test was then performed. Pearson's correlation analyses assessed the relationship between the amount of change of sleepiness and θ on the MDRS/MERS. SPSS Statistics Version 27 (IBM Corp., Armonk, NY, USA) was used for all analyses.

Figure 3
Upright, slumped, leaning backward, and supine postures.



Note. The three sitting postures are adapted from "Postures" by G. Sugamura, 2016, In *Embodied Psychology* (p. 142), Kawashima Shoten. Copyright 2016 by Genji Sugamura. Reprinted with permission.

Results

A total of 17 participants (two men, 15 women, $M_{age} = 18.29$ years, $SD = 0.57$ years) were included in the analysis, excluding one student who took less than the minimum time according to starting time and end time, which the participants were required to report, and one who responded only to the upright posture condition.

MDRS. Although interaction effects were not significant for Posture × Type (F [9, 39] = 1.95, $p = .07$, $\eta_p^2 = .31$), the simple main effect of type on slumped posture was significant (F [3, 13] = 6.12, $p = .008$, $\eta_p^2 = .59$). The post-hoc test revealed that the hyperactive/impulsive type tendency group ($M = 1.14$, $SD = 0.55$) reported higher scores than the inattentive type tendency ($M = -0.78$, $SD = 0.15$) ($p = .02$, $d = 1.56$, 95% CI [0.28, 3.55]) and non-ADHD tendency groups ($M = -0.13$, $SD = 0.58$) ($p = .03$, $d = 2.69$, 95% CI [0.09, 2.45]). The simple main effect of posture on the hyperactive/impulsive type tendency was also significant, F [3, 11] = 4.51, $p = .03$, $\eta_p^2 = .55$. The post-hoc test revealed higher scores in the slumped posture ($M = 1.14$, $SD = 0.55$) than in the supine posture ($M = -0.47$, $SD = 1.7$) ($p = .04$, $d = 0.47$, 95% CI [0.07, 3.15]). In addition, the simple main effect of posture on the combined-type tendency group approached significance, F [3, 11] = 3.48, $p < .05$, $\eta_p^2 = .49$. The post-hoc test revealed higher scores in the upright posture ($M = 1.66$, $SD = 1.07$) than in the supine posture ($M = -0.39$, $SD = 0.68$) ($p = .03$, $d = 1.88$, 95% CI [0.17, 3.93]) (Table S1).

MERS. There were significant interaction effects for Posture × Type (F [9, 39] = 2.23, $p = .04$, $\eta_p^2 = .34$). The simple main effect of type on upright posture was significant, F [3, 13] = 6.18, $p = .008$, $\eta_p^2 = .59$. The hyperactive/impulsive-type tendency group ($M = 1.37$, $SD = 1.36$) reported higher scores than the combined-type tendency group ($M = -1.94$, $SD = 1.62$) ($p = .006$, $d = 2.51$, 95% CI [0.88, 5.75]). In addition, the simple main effect of posture on the combined-type tendency group was significant (F [3, 11] = 6.05, $p = .01$, $\eta_p^2 = .62$), revealing higher scores in the supine posture ($M = 0.18$, $SD = 0.37$) than in the upright posture ($M = -1.94$, $SD = 1.62$) ($p = .01$, $d = 1.60$, 95% CI [0.45, 3.79]). The simple main effect of posture on the hyperactive/impulsive-type tendency was also significant, F [3, 11] = 5.53, $p = .02$, $\eta_p^2 = .60$. Individuals in the supine posture ($M = 1.39$, $SD = 1.86$) reported higher scores than those in the slumped posture ($M = -0.66$, $SD = 1.07$) ($p = .04$, $d = 1.54$, 95% CI [0.49, 4.04]). People in the upright posture ($M = 1.37$, $SD = 1.36$) reported higher scores than those in the slumped posture ($p = .004$, $d = 1.54$, 95% CI [0.60, 3.47]) (Table S1).

TMS-J. The main effect of posture on "decentering" was significant, F [3, 39] = 3.66, $p = .02$, $\eta_p^2 = .22$. However, post-hoc tests revealed no significant differences between postures (Tables S2–S5).

Sleepiness. The MDRS and the amount of change of O-VAS/KSS-J were not correlated ($|rs| < .26$, ps > .31, see Table S6 for 95% CI), but the MERS was weakly positively correlated with the KSS-J in the supine posture ($r = .49$, $p < .05$, 95% CI[−0.002, 0.78]) and with the O-VAS in the upright posture ($r = .51$, $p = .04$, 95% CI[0.03, 0.79]) (Tables S6, S7).

Discussion

This study aimed to examine differences in the difficulty and ease of performing a body-scan meditation in four different postures, considering relative ADHD tendencies. The results of the experiment revealed the following four points: (a) for those with hyperactivity/impulsivity tendency, the slumped posture made performing the body-scan meditation a challenge; (b), for the same group, the supine posture made the body-scan meditation easier to perform; (c), for the same group, the upright posture allows great ease in performing body-scan meditation, and creates difficulty for those with combined tendency; and (d) in the upright and supine postures, sleepiness was higher when ratings of ease of performing the body-scan meditation were high. Our hypothesis was supported only to the extent that it was critical to the research question of this study. Given that the groups in this study reflect ADHD tendencies, the results regarding these participants may be applicable to the population with ADHD tendencies, who may be on the spectrum, regardless of diagnosis.

Because approach motivation, which is an impulse to move toward an external object (Harmon-Jones et al., 2013), is lower in the supine position (Harmon-Jones & Peterson, 2009), individuals with hyperactivity/impulsivity tendencies may find the body-scan meditation in the supine position easier than in other postures because impulsivity, which distracts from the body-scan practice, was alleviated. Further, in the supine posture, the entire back is placed on the floor, and the subject feels gravity. From the perspective of sensory integration, "gravitational security" (p. 55) is an important factor (Ayres, 2005), but problems with sensory integration in ADHD individuals have been noted (Ghanizadeh, 2011). In the supine position, a posture with a larger gravity-sensing area and more stability than the seated position (Barra et al., 2015), psychological stability was achieved, which may have led to successful meditation.

Contrastingly, the slumped posture was the most difficult for the participants with hyperactive/impulsive tendency while performing the body scan meditation. Further, a slumped posture has been found to decrease motivation for tasks that evoke feelings of learned helplessness (Riskind & Gotay, 1982). Because mindfulness cannot be successfully practiced in a swift manner, a slumped posture would understandably make it more challenging. Moreover, individuals with ADHD tend to experience delay aversion, which refers to their frustration when they do not receive immediate rewards and is particularly associated with impulsivity (Sonuga-Barke, 2002). These traits may lead to the implication that people with hyperactivity and impulsivity tendencies may find the practice difficult in a slumped posture, but in terms of statistical protocol, it should be interpreted with great caution.

The present study found that the upright posture made it easier for individuals with hyperactive/impulsive tendency to practice the body-scan meditation, which may confirm Riskind and Gotay's (1982) findings that the upright posture was more effective in the task than the slumped posture. However, when the inattentive tendency was added, performing the body-scan meditation in an upright posture became difficult. This result may be because the limited attentional resources of distracted participants were devoted to keeping their backs straight, impeding their concentration on the body-scan meditation.

Kabat-Zinn (2012) considers sleepiness a common problem for individuals who begin mindfulness. This study found that sleepiness was associated with greater ease in performing a body-scan meditation in the upright and supine postures, which were also associated with greater ease of mindfulness practice. The reason that the correlation between sleepiness and feasibility of the body scan was observed only in two postures that promote the practice is considered because the ease of practice induced a feeling of relaxation that is a secondary effect and caused sleepiness. From this perspective, sleepiness during practice is an obstacle, but on the other hand, it is a sign of the feasibility of practice.

General Discussion

In Study 1, we collected reactions during mindfulness exercises and created the preliminary items, and in Study 2, we determined MERS and MDRS and confirmed validities. Based on the finding that the interval of the rating scale is not always symmetrical between reversal and non-reversal items (Wakita, 2004), these two independent measures may more accurately reflect the subtle differences between the two aspects of ease and difficulty of practice than combining them into a single measure.

Although most of the existing scales measure trait or state mindfulness, these scales can estimate to what extent encouraging practical procedures, such as meditations, can affect beginners. In addition, because these scales were created based on intuitive impressions for beginners, they may be able to measure the ease and difficulty, for beginners, of each meditation. On the other hand, it may be possible to evaluate whether meditation itself is easy or difficult to perform. These features could serve as an indicator for improving the quality of instruction and programs.

The main results of Study 3 are that individuals with hyperactive and impulsive tendencies should be discouraged from practicing mindfulness in the slumped posture and encouraged to practice in the supine and upright postures, which is in line with previous findings and supports the hypothesis of this study. Despite the availability of studies on mindfulness interventions for individuals with ADHD, few of them have focused on the ease or difficulty performing mindfulness, or on posture, and only limited studies have compared individuals with and without ADHD. Therefore, our findings will facilitate mindfulness, which has been used as an approach to treat ADHD symptoms in the past. Because of these new aspects, our findings will provide theoretical insights into the development of holistic nursing practice for individuals with ADHD. Also, future studies should compare the effects of posture on the feasibility of mindfulness practices with other procedures, as Zylowska (2012) indicated. In terms of dynamic meditation practices in educational settings, Zylowska's (2012) procedures can be compared with mindfulness combined with activities that are familiar to Japanese schools. For instance, it is revealed that radio *taiso*, the traditional exercise in Japanese schools, is an easier way to improve state mindfulness for people with hyperactivity/impulsivity tendencies than mindful yoga (Fukuichi & Sugamura, 2022). That may be a more inclusive way to facilitate meditation in schools.

One limitation of this study is the small sample size. A small sample size tends to result in larger and highly variable effect sizes than wider studies (Slavin & Smith, 2008). Although the effect sizes are sufficiently large in this study, it may be because of the small sample size. Furthermore, it is not certain whether the participants accurately represented the population. In order to consider these factors, a follow-up study with a larger sample size to generalize the results is necessary. Additionally, the results of this study, comprising people with relatively higher ADHD tendencies, should be compared with studies involving people who have been diagnosed with ADHD; that is, substantially high ADHD tendencies.

Further, since this study was conducted remotely and on-demand with regard to COVID-19 prevention, we could not perform manipulations at the level of those achieved in the laboratory. As the four postures used in this study were very different, the possibility of confusion was considered very low. However, studying the impact under strict manipulation is essential because the extent to which the back angle changes the effect is unknown.

In the present study, state mindfulness was also measured using the TMS-J, but this did not differ between postures or ADHD tendencies. This result may reflect the fact that the intervention lasted for only 1 day. Since a typical mindfulness program lasts for more than a day, differences may emerge during longer interventions.

Acknowledgement

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Conflict of Interest

The authors declare no conflicts of interest associated with this manuscript.

Disclosure of Related Reports

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site: http://onlinelibrary.wiley.com/doi/10.1111/jpr.12541/suppinfo.

Data S1. Tables S1–S7 indicate the descriptive statistics and the results of analyses of Study 3.

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