



Can mindfulness-based training impact explicit and implicit attitudes and sustainable nutrition behavior? A focus on vegetarianism

Annica Winkelmair^{*}, Petra Jansen

University of Regensburg, Faculty of Human Sciences, Universitätsstraße 31, Regensburg, 93053, Germany

ARTICLE INFO

Keywords:

Mindfulness
Attitudes
Implicit association task
Vegetarian food
Sustainable food consumption
Sustainability
Intervention study

ABSTRACT

Objectives: The aim of this study was to investigate the impact of a mindfulness intervention (IG) compared to an inactive control group (CG) on explicit and implicit attitudes toward vegetarian and meat-based foods, nutrition behavior measures, trait mindfulness and wellbeing.

Methods: In the IG (N = 66), we implemented a mindfulness-based intervention consisting of eight weekly group sessions online, along with an additional half-day session held on campus. The CG (N = 71) received no intervention or training. We employed a pre-/post-intervention design involving questionnaires (trait mindfulness, wellbeing, sustainable nutrition behavior scale), an online supermarket scenario, as well as an explicit rating task and an implicit association task using pictures of vegetarian and meat-based foods. Additionally, a voluntary follow-up testing was conducted two months after the final group session.

Results: No intervention effects were observed on explicit and implicit attitudes, wellbeing, or nutrition behavior measures. However, there was an increase in trait mindfulness within the IG. Exploratory cross-sectional findings indicated that trait mindfulness facets such as “Acting with Awareness” and “Outer Awareness”, along with explicit attitudes, were significant predictors of self-reported sustainable consumption behavior. Additionally, sex and explicit attitudes were identified as significant predictors of vegetarian consumption behavior in the online supermarket task.

Conclusion: Our findings could not substantiate previous claims regarding the potential causal effects of mindfulness practice on sustainable consumption behavior, specifically in the realm of sustainable and vegetarian nutrition, as well as subjective wellbeing. Future studies may benefit from implementing longer-term mindfulness-based interventions and considering other potential decisive factors, such as connectedness to nature and others. Integrating training elements focusing on these specific variables into the intervention could be valuable.

1. Introduction

Nowadays, the significance of sustainable dietary practices has gathered substantial attention due to their multifaceted impact on health, society, and the environment. Sustainable diets encompass preferences for specific types of food, like organic, regional, or seasonal options, as well as the abstinence of meat products in vegan or less strict vegetarian diets. Choosing vegetarian or vegan diets, in particular, enhances personal sustainability, as plant-based food production generally requires less land, water, and energy than animal agriculture. Given that the production and consumption of food can contribute to 19–29% of global anthropogenic greenhouse gas (GHG) emissions (Vermeulen, Campbell, & Ingram, 2012), the promotion of vegetarianism as an exemplary sustainable dietary practice emerges as a pivotal strategy for

addressing contemporary challenges related to health (Hargreaves, Raposo, Saraiva, & Zandonadi, 2021), societal values, and environmental sustainability. However, individual dietary choices are not always guided by rational considerations but are established by social factors, individual feelings, and habits (Anderson, Wormwood, Barrett, & Quigley, 2019). A change in dietary habits may necessitate more than simply understanding the principles of optimal nutrition; it may also entail breaking old habits, for instance. One promising empirical approach to overcome old habits is to incorporate mindfulness practice, as previous research shows a relation between trait mindfulness, disruption of routine, and sustainable behavior (Jansen, Rahe, & Wolff, 2024).

Mindfulness is rooted in Buddhist philosophy; however, it has gained enormous popularity and traction in Western society, commerce, and

^{*} Corresponding author. University of Regensburg; Faculty of Human Sciences; Universitätsstraße 31, 93053, Regensburg, Germany.

E-mail addresses: Annica.Winkelmair@ur.de (A. Winkelmair), Petra.Jansen@ur.de (P. Jansen).

science over the last decade (Grossman, 2015). Following a Western approach, mindfulness can be referred to as “the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment” (Kabat-Zinn, 2003, p. 145). Bishop et al. (2004) propose a two-component model of mindfulness as an operational definition, with the first aspect involving the self-regulation of attention and the capacity to maintain, shift, and restrain elaborate processing of thoughts and emotions. The second component further defines mindfulness as a specific orientation toward one’s experiences, characterized by curiosity, openness, and acceptance of all emerging inner experiences. This multidimensionality is also evident in the conceptualization of self-report measures used to assess mindfulness as a trait. An example is the Comprehensive Inventory of Mindfulness Experience by Bergomi, Tschacher, and Kupper (2014), which captures trait mindfulness across eight subdimensions and specifically distinguishes the aspect of awareness into inner and outer awareness. Mindfulness can also be described as a state that arises through regular meditation practices, such as sitting or body-oriented meditation, as well as an intervention (Vago & Silbersweig, 2012). Furthermore, there is evidence that trait mindfulness can be enhanced through regular meditation or mindfulness practice (Hölzel et al., 2011). An example of a mindfulness-based intervention is the well-established Mindfulness-based stress reduction (MBSR) program by Jon Kabat-Zinn (1990), which we also chose as an intervention for this current study. As mentioned before, cultivating mindfulness could counteract mindless, habit-formed consumption behavior and thus support sustainable practices (see Fischer, Stanszus, Geiger, Grossman, & Schrader, 2017).

1.1. Mindfulness and sustainable consumption

Previous research suggests that mindfulness practice and training may have the potential to foster sustainable consumer behaviors (e. g., Ericson, Kjøenstad, & Anders, 2014; Fischer et al., 2017). According to Fischer et al. (2017) mindfulness can render underlying cognitive-behavioral processes more accessible, thereby enabling more intentional decision-making by disrupting established routines. In the literature, several mechanisms through which mindfulness may be related to sustainability are proposed, including (1) the disruption of routines, (2) the congruence of attitude and behavior, (3) prosocial behavior and connectedness to nature and others, (4) non-material values, and (5) wellbeing (Geiger, Grossman, & Schrader, 2019). The latter relation is consistent with the assumption that personal and planetary wellbeing are intrinsically interlinked (Wamsler et al., 2018). Previous research reveals that mindfulness practice is very influential in subjective wellbeing (Brown & Ryan, 2003). Moreover, in the context of sustainability, it has been shown that engaging in environmentally friendly behavior can satisfy psychological needs, thereby contributing to subjective wellbeing (Kasser, 2017; Ryan, Huta, & Deci, 2008). Additionally, wellbeing may not only be an outcome of individual sustainability behavior but also serve as an antecedent, as positive wellbeing leads people to engage in more prosocial, e. g., eco-friendly behavior (Geiger et al., 2019; Kasser, 2017). However, wellbeing is a complex construct, with two notable approaches emerging in research: the hedonic and eudemonic perspectives (Ryan & Deci, 2001). The hedonic approach focuses on happiness and pleasure; the essential components are life satisfaction and positive and negative moods (Ryff, Boylan, & Kirsch, 2021). The critical elements of eudemonic wellbeing are self-acceptance, positive relations with others, environmental mastery, autonomy, purpose in life, and personal growth.

There are several factors that are connected with pro-environmental behavior and sustainable consumption, such as one’s values, personal and social norms, the ascription of responsibility, awareness of consequences, attitudes, intentions, perceived behavior control, and habits as proposed by the comprehensive model of determinants of individual environmentally relevant behavior by Klöckner (2013). However, these

factors alone do not fully explain sustainable consumption behavior. Thiermann and Sheate (2020) offer a theoretical expansion to this Comprehensive Action Determination Model by including a relational pathway based on connectedness with nature, empathy, and compassion in addition to the normative pathway for pro-environmental behaviors. According to their 2-pathway model, enhancing activation of the relational pathway leads to greater internalization of motivation for the behavior. Cultivating mindfulness has shown effects across various components of this 2-pathway model and provides deep transformative effects on the inner dimensions of individuals (Wamsler, 2019).

While most of the previous studies regarding mindfulness and sustainable consumption behavior show only small effects and are mainly cross-sectional (Geiger et al., 2019), there are a few intervention studies. For instance, in the pre-post study of Geiger, Fischer, Schrader, and Grossman (2020), the effects of a modified version of MBSR training that included exercises for sustainable consumption on sustainability-related variables were tested (total N = 137). Their intervention led to an increase in trait mindfulness and wellbeing as well as a reduction in materialistic values. Nonetheless, it did not directly influence sustainable consumption behavior or associated attitudes. According to the authors, this implies that the adapted MBSR training may primarily impact variables distal to behavior, which could subsequently exert an indirect influence on long-term consumption behavior. In another randomized controlled trial (N = 125), attending either an eight-week MBSR training or eight weeks of Health Enhancement Program predicted increases in pro-environmental behavior and sustainable wellbeing relative to a waitlist (Riordan et al., 2022). However, the latter finding was not robust to multiple imputations. In these two studies, sustainable behavior was investigated in a rather global way and not regarding specific aspects.

1.2. Mindfulness and sustainable nutrition

The connection between mindfulness and sustainable consumption might be particularly promising within the context of sustainable dietary behavior. As a significant part of our daily eating behavior is driven by routines, habits stand out as one of the most influential predictors of eating behavior (Van’t Riet, Sijtsema, Dagevos, & De Bruijn, 2011). Habit-driven food choices are often accompanied by a lack of awareness regarding our nutrition behavior that extends from the source of our daily meals to considerations of “what” we eat, “how much” we eat, “how” we eat, and “why” we eat (Stanszus, Frank, & Geiger, 2019). Previous research provides evidence for the positive impact of mindfulness practice on conscious eating behavior (e. g., Beshara, Hutchinson, & Wilson, 2013). In the study of Hunecke and Richter (2019), a direct connection was identified between self-reported sustainable food consumption and trait mindfulness, particularly for the facet of “Acting with Awareness”.

In the field of sustainable nutrition, research findings from intervention studies with mindfulness-based interventions are limited. In the pilot experimental study of Frank, Heimann, Kolbe, and Schuster (2022), a single guided introspection to reflect on one’s own emotional reactions led to a decrease and, therefore, lower negative attitudes toward reducing meat consumption compared to the control group (N = 75). The intervention study of Stanszus et al. (2019), however, reveals limited effects on sustainable nutrition behaviors that were only apparent in the qualitative data in pre-behavioral stages of consumption, like attitudes and intentions.

From a theoretical point of view, attitudes and intentions are considered significant predictors in explaining real behavior (Ajzen & Fishbein, 1977; Klöckner, 2013) and, particularly, within the domain of nutrition behavior (e. g., Berndsen & Pligt, 2004). Nevertheless, from an experimental point of view, there is a significant range of variability in the consistency between attitudes and behavior (Glasman, Albarracín, & Glasman, 2006), highlighting the existence of an attitude-behavior gap. One reason for this might be that in most of the mentioned study designs,

attitudes were only assessed explicitly in the form of self-reports, while implicit aspects of attitudes were not captured. Previous research shows that explicit and implicit attitudes might not always correspond with each other and, therefore, reveal an incongruence between explicit and implicit orientations, especially in the context of sustainability (e. g., Beattie & McGuire, 2012; Steiner, Geissler, Schreder, & Zenk, 2018). In consumption, decision-making is particularly influenced by an automatic, unconscious component (Panzone, Hilton, Sale, & Cohen, 2016), underscoring the importance of considering not only explicit but also implicit attitudes.

1.3. Explicit and implicit attitudes in the context of nutrition: A focus on vegetarian foods

Attitudes can be differentiated into explicit - that can be reported and consciously controlled - and implicit ones. For the latter, there is no explicit awareness and their activation cannot be controlled (Rydell & McConnell, 2006). Thus, implicit measurements to capture these uncontrolled, unconscious attitudinal aspects must be applied, such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) which has been used in numerous studies in the context of nutrition (e. g., Barnes-Holmes, Murtagh, Barnes-Holmes, & Stewart, 2010; De Houwer & De Bruycker, 2007). Recently, it was found to be reliable for assessing pro-vegetarian implicit attitudes in a cross-sectional online study (N = 261) by Winkelmair, Schroter and Jansen (2024, under review), with $r_s = 0.86$.

In the study of Winkelmair and Jansen (2023), the impact of two conceptually different twelve-week-long mindfulness interventions without any sustainability-related content - a compassion and caring-based mental training and an adapted MBSR training - and a stress-reduction training on both explicit and implicit affective attitudes toward vegetarian foods was investigated. Their results showed an improvement in the explicit attitudes toward vegetarian foods for all three groups (total N = 91). There were no significant effects regarding the implicit affective attitudes. However, this may also be due to the choice of the implicit method of the affective priming paradigm, as priming procedures have been to be less reliable (Cameron, Brown-Iannuzzi, & Payne, 2012).

Measuring both explicit and implicit aspects could provide valuable insights into potential modifications in attitudes and behavior following a mindfulness intervention, as previous research indicates that mindfulness can yield benefits for explicit and implicit processes in various domains, such as mood regulation (Remmers, Topolinski, & Koole, 2016). Moreover, there is evidence that explicit and implicit attitudes toward vegetarian foods might correlate with each other, but not necessarily at each time point of measurement during a mindfulness intervention (Winkelmair & Jansen, 2023). Therefore, both explicit and implicit measurements should be employed as equally valuable methods to achieve a more comprehensive understanding of attitudes, which is crucial for the development of interventions fostering the transition toward sustainable behavior.

1.4. The goal of this study

In summary, the results of previous intervention studies on the influence of mindfulness-based interventions on sustainable behavior and attitudes in the context of nutrition are rather heterogeneous. The present study aimed to investigate the impact of an online mindfulness intervention (IG) compared to a control group (CG) that does not receive any training or intervention. We applied the evidence-based MBSR intervention as it has gained significant attention worldwide (Rosenberg, 2004), making it easily accessible to the general population. Moreover, several German health insurance companies currently partially cover the costs of MBSR courses, thereby expanding accessibility to a wider audience. Consequently, the applicability of this intervention is notably high. However, the IG was differentiated into

two subgroups: one purely mindfulness-based (IGm), and the other incorporating educational elements on sustainable nutrition (IGe). We have implemented this division to examine potential differences in effects, as some previous studies included mindfulness-based interventions with integrated sustainability-related content (e. g., Geiger et al., 2020; Stanszus et al., 2019), while others exclusively practiced mindfulness (e. g., Winkelmair & Jansen, 2023). We measured both explicit and implicit attitudes toward vegetarian and meat-based foods, as well as sustainable consumption behavior in the context of nutrition, specifically focusing on vegetarian food, trait mindfulness, and subjective wellbeing. Our hypotheses were as follows:

H1. There is an improvement in the explicit attitudes pre-post in the IG compared to the CG. We expect the same effect for the implicit attitudes.

H2. There is an improvement in the sustainable nutrition behavior pre-post measured by self-report and vegetarian consumption behavior in an online supermarket scenario in the IG compared to the CG.

H3. There is an increase in trait mindfulness pre-post in the IG compared to the CG.

H4. There is an improvement in wellbeing pre-post in the IG compared to the CG.

Exploratorily, we were interested in the differences in the impact of the two IG subgroups IGm and IGe, regarding the established hypotheses. Also, as previous research shows that vegetarians/vegans and omnivores differ regarding their explicit and implicit attitudes toward vegetarian products in comparison to meat products, we wanted to investigate whether the vegetarian/vegan and omnivore participants of our study differ in their explicit and implicit attitudes and regarding their sustainable food consumption behaviors. In addition, we were also interested in the factors that predict sustainable and vegetarian nutrition behavior. Therefore, the factors of intervention group, sex, pro-vegetarian explicit and implicit attitudes, diet, wellbeing, and the different aspects of trait mindfulness, as previous research highlighted the importance of specific dimensions, were considered.

2. Materials and methods

2.1. Participants

The required number of participants was calculated using G*power (Faul, Erdfelder, Lang, & Buchner, 2007). With an effect size of $f = 0.15$, a power of $1 - \beta = 0.80$, and an alpha standard probability of 0.025 (because of two measurements for Hypotheses 1 and 2), a power analysis for the ANOVAs of our main Hypothesis 1 and 2 with one within-subjects (time of measurement: pre and post-intervention) and one between-subjects (group assignment) factor resulted in a required sample size of N = 110. A small effect size was assumed, as previous studies on mindfulness interventions regarding explicit and implicit attitudes toward foods have demonstrated rather heterogeneous and medium to small effect sizes. For example, in the study by Winkelmair and Jansen (2023), the effect sizes for the repeated measures ANOVAs regarding explicit attitudes were $\eta^2 = 0.048$ for vegetarian food pictures and partial $\eta^2 = 0.058$ for meat-based foods.

This intervention study was conducted in line with the ethical guidelines of the Helsinki Declaration and has been approved by the ethics board of the University of Regensburg (reference number: 20-1978_2-101). It was preregistered prior to data collection at OSF: <https://osf.io/fpb48>. The participants were recruited through the newsletter of the institute of sports science at the University of Regensburg and student groups on various social media platforms. Students of Applied Movement Science were incentivized with course credit for their participation. It is important to note that there was no academic connection between the investigator and the participants, aiming to mitigate potential social desirability effects.

141 participants took part in the pretest one week prior to the intervention. During the intervention, two participants in the IG left the study due to a lack of time to attend the weekly group sessions. Additionally, one participant in the IG did not respond to the invitation for the posttest. We collected data from 138 participants in the posttest; however, one further person in the IG had to be excluded as they did not meet the minimum requirement of attending six of the weekly course sessions, leaving a final sample of N = 137 for pre- and posttest analyses, consisting of 75 women and 62 men (*M age* = 22.70 years, *SD* = 3.69). In the follow-up, 130 participants (70 men, 60 women; *M age* = 22.78 years, *SD* = 3.74) took part in the testing, as seven participants did not answer the invitation for the follow-up. See Fig. 1 for participation throughout the course of the study.

Participants were mostly students (94.2%) of Applied Movement Science. They were informed that this study aimed to explore the relationship between mindfulness and attitudes toward sustainability. During the tests, they were instructed to complete various tasks involving the categorization of images and words, as well as to answer some questions about themselves and their daily experiences. As such, no assertion was made regarding the anticipated direction of the intervention (i. e., fostering pro-vegetarian attitudes).

The demographic characteristics of both groups and variables of interest describing the sample are individually presented in Table 1. Specifically, we analyzed potential group differences between the IG and CG; however, no significant group differences were found, see Table 1.

2.2. Procedure and design

2.2.1. Mindfulness-based intervention (IG)

This mindfulness curriculum consisted of eight weekly group sessions á 90 minutes that were taught online by two experienced and certified female MBSR teachers. We chose online mindfulness training to expand our reach to a larger number of participants. The efficacy of online mindfulness interventions in enhancing wellbeing and reducing stress has already been established (see Bossi et al., 2022). To maintain small group sizes, we arranged four groups at various time slots, leading to group sizes ranging between 17 and 18 participants. The content and exercises of this adapted MBSR course were taught in line with the

original course of Kabat-Zinn (1990), with the exception of the weekly sessions being shortened to 90 minutes. The main elements included in the curriculum were mindful eating (such as the raisin exercise), body scan, walking and sitting meditation, yoga, breath exercises, and Loving-kindness meditation training. Additionally, each session incorporated guidance from mindfulness teachers on specific topics. These topics included understanding the concept and practice of mindfulness, the role of perception in coping with challenges, techniques for expanding the scope of perception, mindfully appreciating positive experiences, navigating and learning from challenging experiences, comprehending the influence of stress on behavior and communication, and cultivating a mindset of compassion, both towards others and oneself, among other topics. The group sessions provided space for self-reflection and the exchange of experiences and challenges. Furthermore, participants were assigned exercises to practice at home. In addition to the weekly sessions, there was an extra half-day session (4 h) held on campus at the midpoint of the course. Participants were randomly assigned to one of two subgroups of the IG that differed in relation to the content of this additional half-day session, but not their weekly group sessions: In IGm (pure mindfulness group), there was a “half day of mindfulness” following the original curriculum by Jon Kabat-Zinn (1990) incorporating the main exercises of the weekly group sessions. In IGe (mindfulness and sustainability education), an interactive workshop on sustainable nutrition featuring elements of education for sustainable development was conducted by an experienced trainer in the field. The workshop aimed to impart knowledge around sustainable nutrition, covering topics such as health, the natural foundations of life, the vision of living healthily on a healthy Earth, the Planetary Health Diet as the menu of the future, and the practical application of this knowledge. Both elements of the teacher’s presentation and interactive components were integrated. It’s important to note that there were no discussion or incorporation of sustainability-related content in any of the weekly group sessions; this topic was only addressed in the workshop of IGe.

2.2.2. Experimental pre/post/follow-up design

All participants were randomly assigned to the IG or the CG, aiming for equally distributed sample sizes of both groups. The IG participated in the mindfulness-based intervention, whereas the CG did not undergo

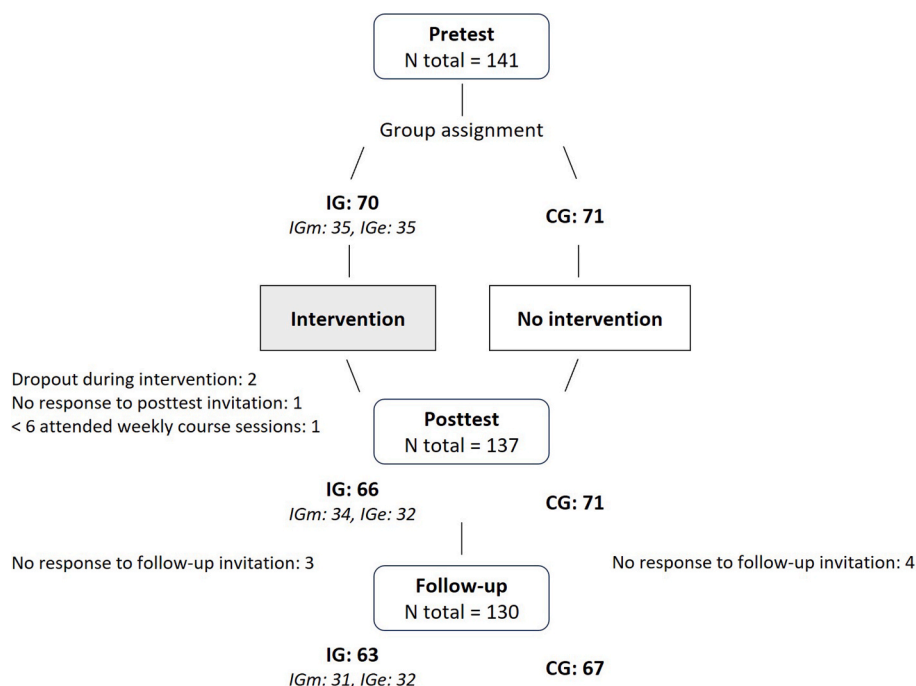


Fig. 1. Participant flow diagram.

Table 1
Demographic characteristics of intervention group (IG) and control group (CG).

	IG	CG	Difference
Age <i>M</i> (<i>SD</i>)	22.48 (3.78)	22.9 (3.63)	$p = 0.420$ ₂
Sex <i>n</i> [%]			$p = 0.864$ ₃
Female	37 [56.1%]	38 [53.5%]	
Male	29 [43.9%]	33 [46.5%]	
Previous meditation experience			$p = 0.867$ ₂
Never <i>n</i> [%]	6 [9.1%]	5 [7.6%]	
Tried <i>n</i> [%]	32 [48.5%]	17 [25.8%]	
Regularly <i>n</i> [%]	28 [42.4%]	44 [66.6%]	
/ minutes per week <i>M</i> (<i>SD</i>)	12.60 (16.19)	15.47 (22.61)	
Previous yoga experience			$p = 0.787$ ₂
Never <i>n</i> [%]	5 [7.6%]	3 [4.2%]	
Tried <i>n</i> [%]	17 [25.8%]	29 [40.8%]	
Regularly <i>n</i> [%]	44 [66.6%]	39 [55%]	
/ minutes per week <i>M</i> (<i>SD</i>)	25.58 (32.97)	33.42 (65.03)	
Previous mindfulness experience <i>n</i> [%]			$p = 0.384$ ₄
Never	36 [54.5%]	46 [64.8%]	
Tried	26 [39.4%]	20 [28.2%]	
Previous MBSR course attendance	4 [6.1%]	5 [7.0%]	
Eating habits in pretest <i>n</i> [%]			$p = 0.253$ ₃
Vegetarian/vegan	15 [22.7%]	3 [32.4%]	
Omnivore	51 [77.3%]	48 [67.6%]	
Importance diet in pretest <i>M</i> (<i>SD</i>) ¹	4.17 (0.78)	4.24 (0.75)	$p = 0.567$ ₂
Main reason for diet choice in pretest <i>n</i> [%] (the three out of seven most frequently specified criteria)	Pleasure: 23 [34.8%], Muscles: 16 [24.2%], Moral: 13 [9.7%]	Pleasure: 21 [29.6%], Health: 18 [25.4%], Moral: 16 [22.5%]	$p = 0.056$ ₄
Eating habits in posttest <i>n</i> [%]			$p = 0.387$ ₃
Vegetarian/vegan	18 [27.3%]	22 [31%]	
Omnivore	48 [72.7%]	49 [69%]	
Importance diet in posttest <i>M</i> (<i>SD</i>) ¹	4.15 (0.79)	4.18 (0.70)	$p = 0.905$ ₂
Main reason for diet choice in posttest <i>n</i> [%] (the three out of seven most frequently specified criteria)	Pleasure: 18 [27.3%], Moral: 15 [22.7%], Muscles: 13 [19.7%]	Pleasure: 21 [29.6%], Health: 21 [29.6%], Muscles: 12 [16.9%]	$p = 0.658$ ₄
Eating habits in follow-up <i>n</i> [%]			$p = 0.282$ ₃
Vegetarian/vegan	15 [22.7%]	20 [28.2%]	
Omnivore	48 [72.7%]	47 [66.2%]	
Importance diet in follow-up <i>M</i> (<i>SD</i>) ¹	4.13 [0.83]	4.18 [0.60]	$p = 0.978$ ₂
Main reason for diet choice in follow-up <i>n</i> [%] (the three out of seven most frequently specified criteria)	Pleasure: 21 [31.8%], Muscles: 13 [19.7%], Moral: 12 [18.2%]	Pleasure: 21 [29.6%], Health: 19 [26.8%], Moral: 15 [21.1%]	$p = 0.479$ ₄

Notes. ¹ Scale (1) = not at all important - (5) = very much important/ ² Mann-Whitney-U Test/ ³ Chi-Square Test/ ⁴ Fisher-exact Test.

any treatment or course. Participants were informed of their group assignment immediately after the pretest, as the weekly IG sessions were scheduled to begin the following week. The CG was instructed to simply wait until they received the invitation to participate in the posttest, as they would not be attending any intervention sessions. Ten participants had to be manually reassigned from the IG to the CG due to individual scheduling conflicts with the intervention group sessions. There were three-time points of measurement: (1) pretest: one week before starting of the mindfulness-based intervention in the IG, (2) posttest: one week after the final group session of the intervention; and (3) follow-up (optional): around two months after the final group session. All participants, regardless of their group assignment in IG or CG, had to take part in pre- and posttest, whereas participation in the follow-up testing was on a voluntary basis. All three tests lasted approximately 30 min each and were conducted online using the programs OpenSesame (Mathôt, Schreij, & Theeuwes, 2012), SurveyJS, and Jatos.org (Lange, Kühn, & Filevich, 2015). Participants were instructed to conduct the tests in a quiet and disturbance-free environment. Participation required the use of a computer; a phone or tablet was not sufficient. All three time points of measurement included the following questionnaires and tasks in the following order: Implicit Association Task (Greenwald et al., 1998), Feeling Thermometer (Beattie & McGuire, 2012), Sustainability Check, Online Supermarket Task (based on Zahedi, Öznur Akalin, Lawrence, Baumann, & Sommer, 2022), Comprehensive Inventory of Mindfulness Experience (Bergomi et al., 2014), Sustainable Consumption Behavior - Nutrition Scale (Geiger et al., 2020), Brief Inventory of Thriving (Hausler et al., 2017; Su, Tay, & Diener, 2014), and a demographic questionnaire. In addition, participants in the IG were asked questions about the potential adverse effects of the mindfulness intervention, as well as their perceived benefit, engagement, and acceptability of the program in the posttest and continued engagement with the topics after the final course session in the follow-up.

2.3. Measures

We report reliability values (pretest data: N = 141) for relevant measures in this study.

2.3.1. Demographic questionnaire

We registered demographic data regarding sex, age, education, mother tongue, frequency and duration of meditation and yoga practice, previous experiences with MBSR as well as eating habits (vegan, vegetarian, omnivorous), importance and reasons for the personal dietary choice (health, moral, sustainability, pleasure, allergy, finance, muscle building) in the pretest. In the posttest and follow-up, participants were asked if there had been a change in their dietary habits between the pre- and posttest or between the posttest and follow-up.

2.3.2. Engagement and perceived adverse effects in the IG

We assessed the perceived benefit, engagement, and acceptability of the intervention by using the inventory of Medicott et al. (2021): Participants were asked to report the number of group sessions they attended (scale 1–8), as well as the number of days and minutes they spent on average each week practicing mindfulness outside of the group sessions. In addition, the following four statements had to be rated from 1 to 10: “How much do you feel that you benefitted from the course?”, “Please rate the quality of teaching.”, “Mindfulness courses should be made widely available to students at our university.”, and “How likely are you to use mindfulness in the future?”. We calculated a mean of these four ratings as a total acceptability score of the mindfulness course. In the IGE, the same four statements were presented separately regarding the workshop on sustainable nutrition, with the additional question, “Taking part in the workshop has increased my knowledge of sustainable nutrition.” (scale 1–10). The mean of these five statements was calculated to obtain the total acceptability score of the workshop.

Moreover, for exploratory reasons, we registered the perceived

positive and negative effects of the mindfulness intervention on physical and mental health following [Park, Riley, and Braun \(2016\)](#). Participants were asked to describe the most significant positive impacts of the MBSR course on their physical and mental health and whether they experienced any negative effects despite the positive impacts, using three short open-ended text boxes for each question. In addition, we used the questions of [Baer et al. \(2021\)](#) to register unpleasant experiences during the mindfulness course, perceived harm from the course, and support for any difficult experiences. Participants were asked how often the mindfulness course led to them having unpleasant thoughts or feelings (never; occasionally; less than once a week, but several times during the course; about once a week; several times a week; daily or almost daily), how upsetting these experiences were (not at all; somewhat; quite a bit; extremely), how harmful the course for them was (not at all; somewhat; quite a bit; extremely), if they told anyone about the unpleasantness or harm, or seek any help or support, and if so, who they approached (mindfulness teacher; family member or friend; a doctor, counselor or another mental health professional; someone else) and whether they received adequate support in managing the difficulties on a scale ranging from (1) = no support or unhelpful support to (5) = very helpful support. As the weekly group sessions took place online, and the day of mindfulness or the workshop was conducted in person on campus, we also gathered feedback for this mode of implementation.

2.3.3. Mindfulness measurement

The Comprehensive Inventory of Mindfulness Experience (CHIME; [Bergomi et al., 2014](#)) was used for measuring aspects of trait mindfulness. Comprising 37 items on a 6-point Likert scale from (1) = almost never to (6) = almost always, the CHIME captures eight facets of mindfulness: “Inner Awareness” (e. g., “I clearly notice changes in my body, such as quicker or slower breathing.”; $\omega = 0.68$), “Outer Awareness” (e. g., “I notice sounds in my environment, such as birds chirping or cars passing.”; $\omega = 0.80$), “Acting with Awareness” (e. g., “In everyday life, I get distracted by memories, images or reverie.”; $\omega = 0.61$), “Openness” (e. g., “I try to distract myself when I feel unpleasant emotions.”; $\omega = 0.76$), “Acceptance” (e. g., “Even when I make a big mistake, I treat myself with understanding.”; $\omega = 0.89$), “Decentering/Nonreact” (e. g., “When I experience distressing thoughts or images, I am able just to notice them without having to react immediately.”; $\omega = 0.83$), “Insight” (e. g., “I need to smile when I notice how I sometimes see things as more difficult than they actually are.”; $\omega = 0.76$), and “Relativity of Thoughts” (e. g., “It is clear to me that my evaluations of situations and people can easily change.”; $\omega = 0.63$). The mean value for each subscale and for the CHIME overall score ($\omega = 0.90$) were computed.

2.3.4. Wellbeing

Wellbeing was assessed using the Brief Inventory of Thriving (BIT; [Hausler et al., 2017](#); [Su et al., 2014](#)). In the BIT, ten items (e. g., “I am optimistic about my future.”) must be evaluated on a 5-point Likert scale from (1) = strongly disagree to (5) = strongly agree. As a total score of wellbeing, the mean value over all items was composed ($\omega = 0.85$).

2.3.5. Sustainable nutrition behavior

We used the Sustainable Consumption Behavior - Nutrition Scale (SCBN; [Geiger et al., 2020](#)) to measure sustainable food consumption behavior. The SCBN is based on the cube model of sustainable consumption behavior of [Geiger, Fischer, and Schrader \(2018\)](#), encompassing three stages in nutritional consumption (acquisition, usage, disposal), and addressing both the environmental and socioeconomic impacts of these behaviors. It contains 17 items regarding general behaviors (e. g., “I buy fair trade foods (e. g., with a FairTrade Label)”) on a 7-point frequency scale ((0) = never; (2) = sometimes; (4) = often (6) = always) as well as daily behaviors (e. g., “I eat home-grown food.”); on a 7-point frequency scale ((0) = never; (3) = once a week; (6) = daily). We computed the mean value over all items as the global SCBN Score ($\omega = 0.73$).

2.3.6. Vegetarian nutrition behavior

We incorporated an online supermarket scenario as an additional behavioral measure for vegetarian and, thus, sustainable nutrition behavior based on the online supermarket task developed by [Zahedi et al. \(2022\)](#). Participants were instructed as follows: “You want to buy food for yourself in the online supermarket for the next few days. Please choose 20 products.”. They could choose from a selection of 170 products across eight product categories, with each category containing 16–26 items. Each item could only be added once to the cart. The product categories included (1) Bread, rice, pasta, and other grains; (2) Bread spread and breakfast cereals; (3) Eggs and dairy; (4) Convenience products; (5) Meat, poultry, fish and seafood; (6) Fruits and vegetables; (7) Sweets and salty snacks; (8) Oils, seeds, nuts, and legumes. Participants could track the products they had chosen and the quantity of items in their cart. The proportion of vegetarian products (PropVeg) was calculated as an indicator for vegetarian, sustainable nutrition behavior.

2.3.7. Explicit and implicit attitudes toward vegetarian and meat-based foods

We utilized five pictures of vegetarian and five of meat-based foods selected from the image database of [Blechert, Lender, Polk, Busch, and Ohla \(2019\)](#) as stimulus material for both the explicit and implicit attitude tasks to ensure comparability between the two measurements. The pictures were matched in familiarity, arousal, and valence based on the ratings provided by the database.

Explicit attitudes. As an explicit measure of the attitudes toward vegetarian and meat-based foods, the Feeling Thermometer (FT; [Beattie & McGuire, 2012](#)) was used. In this task, participants were first presented with a short fixation cross for 500 ms, followed by a picture of either vegetarian or meat-based food. Subsequently, they were required to rate how warm or cold they felt regarding the presented food product on a 5-point rating scale ranging from (1) = very cold to (5) = very warm, displayed beneath the picture. For a more vivid presentation, the rating scale was colored blue at the left end and red at the right end, with the two colors blending into each other. Overall, the FT consisted of ten trials, with each of the five vegetarian and five meat-based food pictures being presented once. However, if the answer was not given within 5 s, the trial with the respective picture was repeated in the end. We computed the FT Difference Score ($r_s = 0.87$, 95% CI [0.82, 0.90]) by subtracting the mean rating of meat-based food pictures from the mean rating of the vegetarian pictures. Hence, a more positive FT Difference Score reflected a pro-vegetarian explicit attitude, while a negative FT Difference Score indicated a bias toward pro-meat explicit attitudes.

Implicit attitudes. For assessing the implicit attitudes toward vegetarian and meat-based foods, the Implicit Association Task (IAT; [Greenwald et al., 1998](#); [Greenwald et al., 2022](#); [Steiner et al., 2018](#)) was presented. The IAT comprises two target and two attribute categories and various stimuli (target pictures and attribute words). In our study, we used “vegetarian” and “meat” as target categories by utilizing the same ten pictures of vegetarian and meat-based foods as in the FT. As attribute categories, we used “positive” and “negative” by presenting five positive (“Brilliant”; “Loyal”; “Cheerful”; “Meaningful”; “Happy”) and five negative (“Joyless”; “Desolate”; “Mean”; “Moody”; “Horrorified”) words chosen from the Berlin Affective Word List (BAWL-R; [Vö et al., 2009](#)).

Participants were instructed to categorize a stimulus, displayed at the center of the screen, by pressing “D” for the category shown on the left side or “K” for the category presented on the right side. See [Fig. 2](#) for an exemplary sequence of the blocks in the IAT.

In the trials of blocks 1 and 5, participants were tasked with sorting only target pictures into their respective target categories (“vegetarian” or “meat”), which were displayed in black font on the upper left (required response = “D”) and right side (required response = “K”) of the screen. In trials of block 2, only attribute words needed to be sorted into the respective category (“positive” or “negative”), once again presented on the upper left and right side of the screen, this time in a green

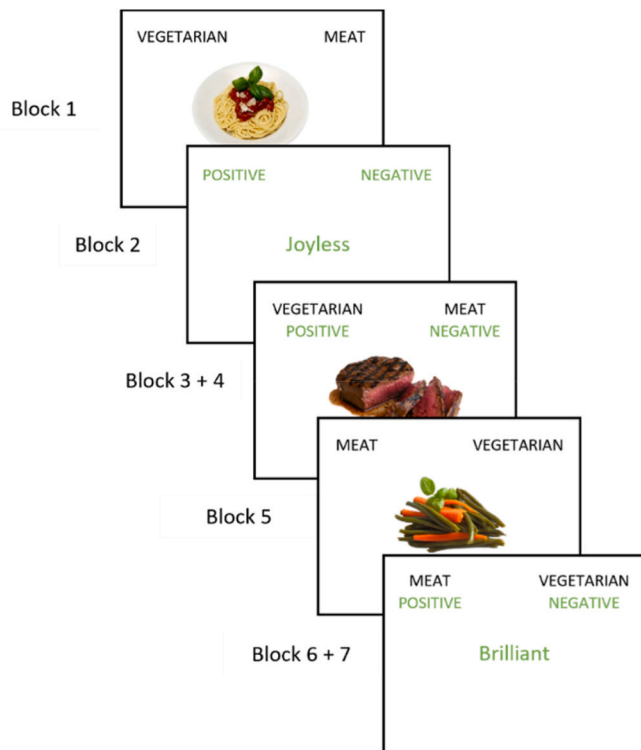


Fig. 2. Exemplary sequence of the blocks in the Implicit Association Task.

font. Blocks 3, 4, 6, and 7 comprised combined blocks, where two categories (one target category in black font and one attribute category in green font) were presented on each side. Table 2 shows an overview of the block and trial routines in the IAT.

In odd-numbered trials, target pictures were displayed in the center of the screen, while in even-numbered trials, attribute words were presented. Each stimulus was associated with only one category and had to be sorted accordingly. The assignment of the sides where the target and attribute categories appeared was randomized among participants. In block 5, the positions of the target categories were exchanged and remained consistent throughout the subsequent blocks. If the participant made a mistake by pressing the wrong key, a red cross appeared beneath the stimulus, and the correct answer had to be given to go on with the next trial.

We used the procedure based on Greenwald et al. (2022) for the calculation of the IAT D-Score. Therefore, we excluded the data of all trials from blocks 1, 2 and 5. Moreover, trials with response times > 10 000 ms were discarded, and participants with more than 10 % response

Table 2
Implicit Association Task (IAT) block and trial routines with exemplary category assignments.

Block number	Block type	Trial numbers	Exemplary category left side ("D" response)	Exemplary category right side ("K" response)
1	Target only	20	Vegetarian	Meat
2	Attribute only	20	Positive	Negative
3	Target and Attribute	20	Vegetarian Positive	Meat Negative
4	Target and Attribute	40	Vegetarian Positive	Meat Negative
5	Target only	20	Meat	Vegetarian
6	Target and Attribute	20	Meat Positive	Vegetarian Negative
7	Target and Attribute	40	Meat Positive	Vegetarian Negative

times < 300 ms were excluded from the analysis. We included error trials in the analysis by summing up the response times of the false response and the (= built-in error penalty, Greenwald et al., 2022). The mean and standard deviation of response times for each block were calculated from the remaining trials. Blocks, in which "vegetarian" was paired with the "positive" and "meat" with the "negative" category, were termed congruent blocks, while those with "meat" and "negative" on one side and "vegetarian" and "positive" on the other side were labeled as incongruent blocks. The mean reaction time of congruent blocks was subtracted from the mean reaction time of incongruent blocks, and the result was divided by the standard deviation. This process was conducted separately for short-combined blocks (20 trials), and long-combined blocks (40 trials), and the averages were then computed to determine the IAT D-Score ($r_S = 0.87$, 95% CI [0.84, 0.89]). Higher D-Scores reflected an implicit preference for the vegetarian food pictures, whereas lower D-Scores indicated a preference for meat-based foods:

$$D = \frac{\frac{(M(IC_2) - M(C_2))}{SD_2} + \frac{(M(IC_1) - M(C_1))}{SD_1}}{2}$$

2.3.8. Sustainability check

To assess the personal evaluation of sustainability, participants had to rate how sustainable they evaluated the vegetarian and meat dishes in the pictures used in the FT and the IAT on a 5-point Likert scale from (1) = not at all to (5) = very much. The pictures were presented in a random order, with each picture being shown separately after a 500 ms fixation cross. The mean value for the vegetarian ($\omega = 0.69$) and the meat-based ($\omega = 0.84$) food pictures was composed. The results showed that there was a significant difference in the personal sustainability evaluation between the vegetarian ($M = 4.06$, $SD = 0.62$) and the meat-based ($M = 1.92$, $SD = 0.73$) foods in the pretest, $t(136) = -21.94$, $p < 0.001$, 95% CI [-2.33, -1.94], $d = 1.14$, indicating a higher sustainability rating of the vegetarian food pictures.

2.4. Statistical analysis

Regarding the sustainability check, to test if there is a difference between the rating of the vegetarian and the meat-based food pictures, matched pairs t-tests were conducted for all measurement times. Also, correlations between the explicit and implicit attitudes were calculated for all measurement times.

To test our hypotheses, mixed ANOVAs were conducted with the between-subject factor group (IG, CG) and the within-subject factor of measurement time (pretest, posttest) for the following dependent variables: FT Difference Score and IAT D-Score (Hypothesis 1), SCBN Score and PropVeg in the online supermarket scenario (Hypothesis 2), CHIME overall score (Hypothesis 3) and BIT mean value (Hypothesis 4). Exploratorily, we also performed mixed ANOVAs, including the follow-up data with the between-subject factor group (IG, CG) and the within-subject factor measurement time (pretest, posttest, follow-up) for the dependent variables FT Difference Score, IAT D-Score, SCBN Score, PropVeg, CHIME overall score, and BIT mean value. Moreover, exploratorily, we were interested in whether there were differences in the effects of the IG subgroups IGm and IGe in comparison to the CG regarding the intervention effects. Therefore, we computed pre-post difference values for the dependent variables of the hypotheses (FT Difference Score, IAT D-Score, SCBN Score, PropVeg, CHIME overall score, BIT mean value) and performed independent t-tests between the three groups (Bonferroni corrected $p = 0.017$).

In further exploratory analyses, multiple linear regression analyses for the SCBN Score and the PropVeg in the online supermarket scenario (posttest) with the predictors group (IG vs. CG), sex (male vs. female), diet (vegetarian/vegan vs. omnivore; in deviation from the preregistration not for PropVeg), FT Difference Score, IAT D-Score, the facets of mindfulness in the CHIME (CHIME_{inner} Awareness, CHIME_{outer} Awareness,

CHIME_{Acting with Awareness}, CHIME_{Acceptance}, CHIME_{Decentering}, CHIME_{Openness}, CHIME_{Relativity of Thoughts}, CHIME_{Insight}) and the BIT mean value were performed. Moreover, regarding the differences between the nutrition groups of vegetarians/vegans and omnivores, we computed independent t-tests or if necessary, equivalent non-parametric tests with the factor nutrition group (vegetarian/vegan vs. omnivore) using pretest data with the dependent variables FT Difference Score, IAT D-Score, SCBN Score and the PropVeg in the online supermarket task. In addition to the preregistered exploratory analyses, we were interested in whether there was an effect of the current diet choice in the pretest on the intervention effect in the IG regarding the explicit and implicit attitudes and the nutrition behavior measures. Therefore, we performed separate mixed ANOVAs with the between-subject factor diet in the pretest (vegetarian/vegan, omnivore) and the within-subject factor of measurement time (pretest, posttest) for the dependent variables FT Difference Score, IAT D-Score, SCBN Score, and PropVeg in the IG. Data preprocessing and analyses were performed using R and IBM Statistics SPSS 28.

3. Results

3.1. Description of the measurement variables

The means and standard deviation of the measurement variables for the whole sample and both groups separately in pretest, posttest, and follow-up are presented in Table 3.

3.2. Acceptability and perceived harmfulness of the intervention (IG)

The average attendance rate in the IG was 7.45 (*SD* = 0.50) for weekly sessions. All participants attended either the “half day of mindfulness” or the workshop, depending on their IG subgroup. Outside of the weekly group sessions, participants spent an average of 2.5 days (*SD* = 1.61) per week practicing mindfulness, such as through homework, for 18.00 min (*SD* = 12.10) each. The mean acceptability score of the mindfulness intervention was *M* = 7.14 (*SD* = 1.74). Table 4 displays the relevant measures of acceptability and perceived harmfulness of the intervention in the IG.

In the IGE, the mean acceptability of the workshop day was *M* = 7.34 (*SD* = 0.79). The perceived knowledge increase was *M* = 7.37 (*SD* = 0.60).

3.3. Correlations of explicit and implicit attitudes

Significant correlations were observed between the FT Difference Score and the IAT D-Score in the pretest, *r* = 0.52, *p* < 0.001, posttest, *r* = 0.46, *p* < 0.001, and follow-up, *r* = 0.42, *p* < 0.001.

3.4. Intervention effect on the explicit and implicit attitudes (Hypothesis 1)

The 2 x 2 ANOVA showed neither a significant interaction effect, *F*(1, 135) = 1.34, *p* = 0.249, nor a main effect of group, *F*(1, 135) = 1.58, *p* = 0.692, nor time, *F*(1, 135) = 2.69, *p* = 0.104, regarding the explicit attitude measure FT Difference Score. For the implicit attitude measure IAT D-Score, the 2 x 2 ANOVA revealed a significant interaction effect, *F*(1, 135) = 6.86, *p* = 0.010, partial η^2 = 0.048. Subsequent Bonferroni-adjusted matched-pairs t-tests (*p* < 0.025) showed a significant difference between the IAT D-Score in the pre- and posttest only in the CG, *t*(70) = 2.74, *p* = 0.008, *d* = 0.33. This indicates a decrease in the IAT D-Score between the pretest (*M* = 2.35, *SD* = 4.14) and posttest (*M* = 1.01, *SD* = 4.61) and, consequently, a decrease in the pro-vegetarian bias. In the IG, no significant difference was observed, *t*(65) = -1.14, *p* = 0.260.

Exploratorily, we also performed two 2 x 3 ANOVAs, including the follow-up data. There were no main effects of time or group and no interaction between both factors regarding the explicit attitude measure

Table 3

Characteristics of the measurement variables for the whole sample and both intervention group (IG) and control group (CG) separately in pretest, posttest, and follow-up.

	Pretest/Posttest/Follow-up		
	IG ¹ <i>M</i> (<i>SD</i>)	CG ² <i>M</i> (<i>SD</i>)	total sample ³ <i>M</i> (<i>SD</i>)
FT ⁴	0.07 (1.58)/0.13 (1.62)/0.24 (1.52)	0.61 (1.68)/0.48 (1.72)/0.72 (1.66)	0.35 (1.65)/0.31 (1.67)/0.49 (1.60)
IAT ⁴	1.94 (4.79)/2.62 (3.97)/2.38 (3.46)	2.35 (4.14)/1.01 (4.61)/1.49 (4.14)	2.15 (4.45)/1.79 (4.37)/1.92 (3.83)
CH overall	3.69 (0.65)/3.81 (0.56)/3.76 (0.53)	3.82 (0.56)/3.80 (0.50)/3.81 (0.56)	3.76 (0.61)/3.80 (0.53)/3.78 (0.54)
CH In.	4.32 (0.86)/4.34 (0.79)/4.33 (0.75)	4.31 (0.70)/4.31 (0.70)/4.34 (0.70)	4.32 (0.78)/4.32 (0.74)/4.34 (0.72)
CH Out.	3.88 (1.02)/3.95 (0.96)/4.10 (0.99)	4.19 (0.97)/4.16 (0.83)/4.23 (0.83)	4.04 (1.00)/4.06 (0.90)/4.18 (0.91)
CH Awa.	3.58 (0.81)/3.70 (0.81)/3.58 (0.86)	3.83 (0.86)/3.91 (0.86)/3.78 (0.88)	3.71 (0.85)/3.81 (0.84)/3.68 (0.88)
CH Acc.	3.34 (1.12)/3.45 (1.05)/3.46 (1.01)	3.41 (1.07)/3.29 (0.97)/3.29 (0.99)	3.37 (1.09)/3.37 (1.01)/3.37 (1.00)
CH Dec.	3.28 (0.88)/3.48 (0.83)/3.40 (0.78)	3.38 (0.92)/3.39 (0.86)/3.44 (0.90)	3.33 (0.90)/3.43 (0.84)/3.42 (0.84)
CH Op.	3.33 (1.14)/3.47 (0.96)/3.31 (0.95)	3.36 (0.99)/3.42 (1.06)/3.36 (1.10)	3.34 (1.06)/3.44 (1.01)/3.33 (1.03)
CH Rel.	3.98 (0.82)/4.17 (0.69)/4.12 (0.83)	4.19 (0.70)/4.12 (0.76)/4.10 (0.76)	4.09 (0.76)/4.15 (0.72)/4.13 (0.79)
CH Ins.	4.00 (0.87)/4.07 (0.77)/4.02 (0.75)	4.15 (0.77)/4.09 (0.82)/4.18 (0.81)	4.07 (0.82)/4.08 (0.79)/4.10 (0.78)
BIT mean	3.76 (0.60)/3.81 (0.60)/3.75 (0.67)	3.93 (0.57)/3.91 (0.47)/3.95 (0.61)	3.85 (0.59)/3.87 (0.53)/3.85 (0.65)
SCBN	3.59 (0.62)/3.63 (0.55)/3.66 (0.56)	3.59 (0.63)/3.59 (0.60)/3.63 (0.56)	3.57 (0.62)/3.61 (0.58)/3.64 (0.56)
PropVeg	0.90 (0.09)/0.90 (0.10)/0.91 (0.08)	0.91 (0.09)/0.91 (0.09)/0.91 (0.09)	0.91 (0.09)/0.90 (0.09)/0.91 (0.09)

Notes. ¹ Pre- and posttest: *N* = 66, follow-up: *N* = 63/ ² Pre- and posttest: *N* = 71, follow-up: *N* = 67/ ³ Pre- and posttest: *N* = 137, follow-up: *N* = 130/ ⁴ Positive means indicate a pro-vegetarian food bias, negative scores a pro-meat-based food bias.

FT = FT Difference Score, IAT = IAT D-Score, CH overall = CHIME overall score, CH In. = CHIME_{Inner Awareness}, CH Out. = CHIME_{Outer Awareness}, CH Awa. = CHIME_{Acting with Awareness}, CH Acc. = CHIME_{Acceptance}, CH Dec. = CHIME_{Decentering}, CH Op. = CHIME_{Openness}, CH Rel. = CHIME_{Relativity of Thoughts}, CH Ins. = CHIME_{Insight}, BIT mean = Brief Inventory of Thriving mean value, SCBN = global Sustainable Consumption Behavior - Nutrition Scale score, PropVeg = proportion of vegetarian products in the online supermarket scenario.

FT Difference Score and the implicit IAT D-Score; see Section 3.4 in [Supplementary Material A](#) for all statistics.

3.5. Intervention effect on the nutrition behavior measures (Hypothesis 2)

Regarding the SCBN Score, the 2 x 2 ANOVA revealed neither a significant interaction effect, *F*(1, 135) = 0.90, *p* = 0.346, nor a main effect of time, *F*(1, 135) = 1.14, *p* = 0.287, nor group, *F*(1, 135) = 0.004, *p* = 0.950. For the PropVeg in the online supermarket scenario, the 2 x 2 ANOVA showed also no significant interaction, *F*(1, 135) = 0.34, *p* = 0.561, main effect of time, *F*(1, 135) = 0.22, *p* = 0.641, or group, *F*(1, 135) = 0.66, *p* = 0.420.

Two exploratory 2 x 3 ANOVA including the follow-up data showed no main effects of time or group and no interaction between both factors regarding the SCBN Score and the PropVeg in the online supermarket, see Section 3.5 in [Supplementary Material A](#) for all statistics.

3.6. Intervention effect on trait mindfulness (Hypothesis 3)

We found a significant interaction effect for the CHIME overall score, *F*(1, 135) = 4.04, *p* = 0.046, partial η^2 = 0.029. Post-hoc performed Bonferroni-adjusted one-tailed matched-pairs t-tests (*p* < 0.025) revealed a significant difference in the CHIME overall score between the

Table 4
Acceptability and perceived harmfulness of the intervention (IG).

	M (SD)	N
Acceptability of the intervention		
1 To what extent do you think you have benefited from attending the mindfulness course? ¹	6.20 (2.03)	65
2 Please rate the quality of the teaching. ²	7.94 (1.80)	66
3 How much do you agree with the following statement: mindfulness courses should be offered to all students. ¹	7.83 (2.05)	66
4 How likely is it that you will continue to practice mindfulness in the future? ¹	6.58 (2.58)	66
Mean Acceptability score (Items 1–4) ¹	7.14 (1.74)	66
Unpleasant experiences in the intervention		
How often have you experienced unpleasant thoughts or feelings as a result of the mindfulness course sessions? ³	2.15 (1.01)	66
How distressing were these [negative emotions] experiences for you? ⁴	1.41 (0.56)	64
How harmful was the course for you? ⁴	1.06 (0.24)	65
Did you receive sufficient support in coping with the difficulties? ⁵	4.25 (0.96)	4

Notes. ¹ Scale (1) = not at all - (10) = very much, ² Scale (1) = very bad - (10) = very good, ³ Scale (1) = never - (6) = daily or almost daily, ⁴ Scale (1) = not at all - (4) = extremely, ⁵ Scale (1) = no support or unhelpful support - (5) = very helpful support.

pre- and posttest for the IG, $t(65) = -2.11, p = 0.019$, indicating an increase in the CHIME overall score pre-post (pretest: $M = 3.69, SD = 0.65$; posttest: $M = 3.81, SD = 0.56$). In the CG, no significant difference was observed, $t(70) = 0.50, p = 0.154$.

The exploratorily performed 2 x 3 ANOVAs, including the follow-up, revealed no main effects of time or group and no interaction between both factors regarding the CHIME overall score, see Section 3.6 in [Supplementary Material A](#) for all statistics.

3.7. Intervention effect on wellbeing (Hypothesis 4)

There was no significant interaction effect, $F(1, 135) = 0.85, p = 0.358$, main effect of group, $F(1, 135) = 2.35, p = 0.128$, or time, $F(1, 135) = 0.21, p = 0.649$, regarding the BIT mean value.

The exploratory 2 x 3 ANOVAs showed no main effects of time or group and no interaction between both factors regarding the BIT mean value; see Section 3.7 in [Supplementary Material A](#) for all statistics.

3.8. Differences between the IG subgroups and the CG regarding the intervention effects (Exploratory analysis)

The independent t-tests (Bonferroni-adjusted $p = 0.017$) revealed no significant differences between the IG subgroups IGm and IGe, and both subgroups and CG regarding the pre-post difference values for the FT Difference Score, IAT D-Score, SCBN Score, PropVeg, CHIME overall score and the BIT mean value, see Section 3.8 [3.8](#) in [Supplementary Material A](#) for all statistics.

3.9. Prediction of nutrition behavior (Exploratory analysis)

Multiple regression analysis for the SCBN Score in the posttest showed that 41% (adjusted $R^2 = 0.35$) of the variance is explained, $F(14, 122) = 6.15, p < 0.001$, with CHIME_{Acting with Awareness}, CHIME_{Outer-Awareness} and the FT Difference Score as significant predictors, see [Table 5a](#). Variance inflation factors (< 1.89) and tolerance (> 0.52) were considered and regarded as appropriate (O'Brien, 2007).

Regarding the PropVeg in the posttest as the dependent variable, multiple linear regression analysis revealed that 44% (adjusted $R^2 = 0.38$) of variance is explained, $F(13, 123) = 7.49, p < 0.001$, with sex (male vs. female) and the FT Difference Score as the only two significant

Table 5a
Regression table for the dependent variable SCBN Score (posttest).

Variable	SCBN Score ¹				
	b	SE	t	p	95% CI
Intercept	2.23	0.38	5.81	< 0.001	[1.47, 2.99]
Sex: male vs. female	0.13	0.10	1.25	0.214	[-0.07, 0.33]
Group: IG vs. CG	-0.11	0.09	-1.28	0.204	[0.28, 0.06]
Diet: veg. vs. omn. ¹	-0.04	0.12	-0.35	0.724	[-0.27, 0.19]
FT ¹	0.09	0.03	2.61	0.010	[0.02, 0.15]
IAT ¹	0.02	0.01	1.65	0.101	[-0.00, 0.04]
CH In. ¹	-0.03	0.07	-0.42	0.677	[-0.18, 0.12]
CH Out. ¹	0.22	0.06	4.00	< 0.001	[0.11, 0.33]
CH AwA. ¹	0.17	0.06	2.97	0.004	[0.06, 0.28]
CH Acc. ¹	-0.03	0.05	-0.54	0.592	[-0.14, 0.08]
CH Dec. ¹	0.05	0.07	0.71	0.481	[-0.08, 0.18]
CH Op. ¹	0.04	0.05	0.83	0.406	[-0.06, 0.13]
CH Rel. ¹	0.00	0.07	0.05	0.959	[-0.13, 0.13]
CH Ins. ¹	0.01	0.07	0.08	0.939	[-0.12, 0.13]
BIT mean ¹	-0.07	0.10	-0.71	0.480	[-0.28, 0.13]

Notes. ¹ Variables measured at posttest. SCBN Score = global Sustainable Consumption Behavior - Nutrition Scale score, IG = intervention group, CG = control group, Diet = vegetarian/vegan vs. omnivore, FT = FT Difference Score, IAT = IAT D-Score, CH In. = CHIME_{Inner Awareness}, CH Out. = CHIME_{Outer Awareness}, CH AwA. = CHIME_{Acting with Awareness}, CH Acc. = CHIME_{Acceptance}, CH Dec. = CHIME_{Decentering}, CH Op. = CHIME_{Openness}, CH Rel. = CHIME_{Relativity of Thoughts}, CH Ins. = CHIME_{Insight}, BIT mean = Brief Inventory of Thriving mean value.

predictors, see [Table 5b](#). Variance inflation factors (< 1.85) and tolerance (> 0.53) were appropriate (O'Brien, 2007).

3.10. Differences between nutrition groups and effects of individual nutrition (Exploratory analysis)

Significant group differences were observed between the nutrition groups vegetarian/vegan and omnivore regarding both explicit and implicit attitude measures FT Difference Score and IAT D-Score, as well as in nutrition behavior measures SCBN Score and PropVeg in the pre-test, see [Table 6](#). Regarding the FT Difference Score, the group of vegetarians/vegans showed an explicit pro-vegetarian bias, while the group of omnivores had an explicit pro-meat bias. In the IAT D-Score, both nutrition groups exhibited an implicit pro-vegetarian bias but with a

Table 5b
Regression table for the dependent variable PropVeg (posttest).

Variable	PropVeg ¹				
	b	SE	t	p	95% CI
Intercept	0.81	0.06	13.98	< 0.001	[0.70, 0.93]
Sex (male vs. female)	0.05	0.02	3.19	0.002	[0.02, 0.08]
Group: IG vs. CG	0.02	0.01	1.16	0.249	[-0.01, 0.04]
FT ¹	0.02	0.00	4.50	< 0.001	[0.01, 0.03]
IAT ¹	0.00	0.00	1.74	0.085	[0.00, 0.01]
CH In. ¹	0.00	0.01	-0.12	0.905	[-0.02, 0.02]
CH Out. ¹	0.00	0.01	0.31	0.761	[-0.01, 0.02]
CH AwA. ¹	0.00	0.01	-0.34	0.736	[-0.02, 0.01]
CH Acc. ¹	0.02	0.01	1.76	0.081	[-0.00, 0.03]
CH Dec. ¹	-0.01	0.01	-0.90	0.371	[-0.03, 0.01]
CH Op. ¹	0.00	0.01	-0.19	0.854	[-0.02, 0.01]
CH Rel. ¹	0.00	0.01	0.34	0.736	[-0.02, 0.02]
CH Ins. ¹	0.00	0.01	-0.42	0.673	[-0.03, 0.02]
BIT mean ¹	0.01	0.02	0.63	0.528	[-0.02, 0.04]

Notes. ¹ Variables measured at posttest. PropVeg = proportion of vegetarian products in the online supermarket scenario, IG = intervention group, CG = control group, Diet = vegetarian/vegan vs. omnivore, FT = FT Difference Score, IAT = IAT D-Score, CH In. = CHIME_{Inner Awareness}, CH Out. = CHIME_{Outer Awareness}, CH AwA. = CHIME_{Acting with Awareness}, CH Acc. = CHIME_{Acceptance}, CH Dec. = CHIME_{Decentering}, CH Op. = CHIME_{Openness}, CH Rel. = CHIME_{Relativity of Thoughts}, CH Ins. = CHIME_{Insight}, BIT mean = Brief Inventory of Thriving mean value.

Table 6
Nutrition group differences (pretest data).

	Nutrition group difference					
	Vegetarian/ vegan M (SD)	Omnivore M (SD)	U	z	p	r
FT ^{a b}	1.79 (1.65)	-0.21 (1.27)	654.00	-5.91	< 0.001	0.55
IAT ^b	5.06 (2.60)	1.03 (4.52)	893.00	-4.75	< 0.001	0.41
PropVeg ^b	0.99 (0.02)	0.88 (0.09)	466.50	-6.99	< 0.001	0.55
			t(135)		p	d
SCBN ^c	3.94 (0.58)	3.43 (0.59)	4.49		< 0.001	0.58

Notes. Vegetarian/vegan: N = 38, omnivore: N = 99 (pretest).
FT = FT Difference Score, IAT = IAT D-Score, PropVeg = proportion of vegetarian products in the online supermarket scenario, SCBN = global Sustainable Consumption Behavior - Nutrition Scale score.

^a Positive means indicate a pro-vegetarian food bias, negative scores a pro-meat-based food bias.

^b Mann-Whitney-U Test.

^c Independent samples t-test.

stronger bias in the group of vegetarians/vegans. Regarding the SCBN Score and PropVeg, the group of vegetarians/vegans revealed significantly higher scores.

Additionally, we explored the effect of the nutrition group (pretest) in the IG. Separate 2 x 2 ANOVAs revealed a significant main effect of diet (pretest) on the FT Difference Score, $F(1, 64) = 23.64, p < 0.001$, the IAT D-Score, $F(1, 64) = 9.11, p = 0.004$, the SCBN Score, $F(1, 64) = 10.06, p = 0.002$, and the PropVeg, $F(1, 64) = 34.91, p < 0.001$. Higher values were observed for the vegetarian/vegan group in all measurements (see Table 7), indicating a stronger pro-vegetarian bias and higher sustainable and vegetarian nutrition behavior.

4. Discussion

This study aimed to empirically explore the effects of mindfulness-based training on explicit and implicit attitudes and behavior-related measures within the context of sustainable, specifically vegetarian, nutrition as well as distal variables such as wellbeing, in comparison to an inactive control group. Furthermore, we considered longer-term effects by including a two-month follow-up period.

4.1. Mindfulness intervention effects

Neither Hypothesis 1 nor 2 could be confirmed. First, our results demonstrated no significant positive intervention effect of the mindfulness-based training in comparison to the CG on the explicit and

Table 7
Characteristics of attitudes and nutrition behavior measures in the intervention group (IG) depending on diet indicated in pretest.

	Pretest/Posttest	
	Vegetarian/vegan M (SD)	Omnivore M (SD)
FT ^a	1.47 (1.89)/1.68 (1.76)	-0.34 (1.21)/-0.36 (1.26)
IAT ^a	4.65 (2.89)/4.62 (3.45)	1.14 (4.96)/2.04 (3.95)
SCBN	3.98 (0.70)/3.97 (0.65)	3.44 (0.55)/3.53 (0.49)
PropVeg	0.99 (0.02)/1.00 (0.01)	0.88 (0.09)/0.87 (0.09)

Notes. Vegetarian/vegan: N = 15, omnivore: N = 61 (pretest).
FT = FT Difference Score, IAT = IAT D-Score, SCBN = global Sustainable Consumption Behavior - Nutrition Scale score, PropVeg = proportion of vegetarian products in the online supermarket scenario.

^a Positive means indicate a pro-vegetarian food bias, negative scores a pro-meat-based food bias.

implicit attitudes. However, regarding the implicit attitude measure of the IAT D-Score, there was a significant pre-post difference in the CG only, indicating a slight shift towards a less pro-vegetarian implicit attitude. Because of this “negative” effect for the control group, it can be concluded that the mindfulness program did not lead to a negative change in attitude. One speculative interpretation of this negative effect in the CG could be that the repeated presentation of the images may have induced an implicit aversion toward them. Second, there were no significant intervention effects regarding sustainable nutrition behavior as measured in the SCBN and vegetarian buying behavior in the online supermarket scenario.

These findings contradict previous research, which suggests that mindfulness interventions may have a positive impact on explicit attitudes toward vegetarian foods but a rather negative influence on explicit attitudes toward meat-based foods, as demonstrated by Winkelmair and Jansen (2023). However, in the study of Winkelmair and Jansen (2023), these effects appeared to be rather general and not specific to the mindfulness training, as they also showed up in the active control group, which received a stress-reduction course. In the study of Stanszus et al. (2019), while quantitative evidence did not indicate an improvement in explicit attitudes toward sustainable food consumption, qualitative interviews revealed strong effects on attitudes and intentions: The authors report that most participants described how their pre-existing attitudes toward sustainable food consumption were strengthened through the mindfulness-based training. However, the sample size in this qualitative study was rather small (N = 11), and participants were partially selected based on extreme pre-post differences in either mindfulness or sustainable consumption measures. In the present study, we solely focused on quantitative changes and did not include qualitative analysis.

It is noteworthy that both explicit and implicit attitudes across our entire sample leaned toward pro-vegetarianism during the pretest. Additionally, the vegetarian nutrition behavior measure, PropVeg, indicated a strong preference for vegetarian foods in both IG and CG during the pretest. Our exploratory analyses revealed significant differences in all attitude and nutrition behavior measures between vegetarian/vegan and omnivore participants. Specifically, the group of vegetarians/vegans consistently exhibited pro-vegetarian explicit and implicit attitudes, as well as higher levels of sustainable and vegetarian consumption behavior. Conversely, the group of omnivores demonstrated a negative FT Difference Score, indicating an explicit preference for meat-containing meals. Given the apparent influence of personal nutrition, we were interested in investigating whether participants’ dietary habits at pretest had an impact on any potential changes observed within the IG in the measured variables, given that within the vegetarian/vegan subgroup, there may have been only limited room for change into a further pro-vegetarian direction. However, as our exploratory analyses revealed, there was neither a positive intervention effect for participants in the IG who reported eating vegetarian or vegan nor for those indicating an omnivorous diet at the time of pretest in both explicit and implicit attitude and nutrition behavior measures.

Moreover, there was no positive effect of the mindfulness intervention on subjective wellbeing in the IG compared to the CG, thus contradicting Hypothesis 4. This lack of effect is in contrast to previous research highlighting the potential positive impact of mindfulness interventions on personal wellbeing (e. g., Brown & Ryan, 2003; Geiger et al., 2020). At the first glance, one reason for these different results might be that in the former studies, mindfulness training was in presence whereas it was online in this study. However, the effectiveness of mindfulness online training for the enhancement of well-being has already been shown (Bossi et al., 2022). The results of the study presented also contradicts correlational studies, where a relation between some aspects of trait mindfulness, namely the facets of “Acting with Awareness”, “Acceptance”, “Inner Awareness”, and “Insight,” were correlated with wellbeing (Jansen, Rahe, & Wolff, 2024). However, mindfulness training and trait mindfulness are two different aspects.

Nevertheless, in accordance with Hypothesis 3, a significant increase

in trait mindfulness, as measured by the CHIME overall score, was observed due to the intervention. Thus, a near-transfer effect was demonstrated. But even though our intervention was, in general, effective at enhancing personal overall mindfulness, there were no far transfer effects, meaning positive effects on either the explicit and implicit attitudes or the self-reported sustainable nutrition behavior and vegetarian buying behavior.

The absence of positive effects on attitudes and nutrition behavior could be attributed to the relatively short duration of eight weekly group sessions. This is notable considering the challenges associated with behavior change and the understanding that mindfulness is a personal practice that requires time to cultivate and may take several years to integrate into specific areas of life, such as consumption (Thiermann, Sheate, & Vercaemmen, 2020). Furthermore, our exploratory analysis of the two-month follow-up period did not reveal any significant effects across all hypotheses. Given the time needed to establish consumption habits, expecting substantial changes within a brief two-month timeframe may be overly optimistic (Geiger et al., 2020). Another potential explanation could lie in the content of the mindfulness intervention curriculum. Previous studies investigating the effects of mindfulness interventions on sustainable consumption often included topics related to sustainable consumption within the mindfulness curriculum (e. g., Stanszus et al., 2019). We observed no significant differences between the effects of the two intervention subgroups, IGM and IGE, bearing in mind the small sample size for each group when compared to each other and to the CG concerning potential pre-post differences in attitudes and nutrition behavior measures. However, it is possible that the brief duration of the 4 h workshop did not allow for the adequate impartation of knowledge, resulting in no substantial difference between the two subgroups. Moreover, in the 2-pathway model of pro-environmental behaviors proposed by Thiermann and Sheate (2020), in addition to the normative pathway for pro-environmental behaviors, they also propose a relational pathway based on connectedness with nature, empathy, and compassion. Mindfulness, as an experiential strategy, has documented effects across most elements of the 2-pathway model. Our mindfulness intervention was based on the original MBSR course of Kabat-Zinn (1990), emphasizing cognitive elements of mindfulness and qualities of awareness. Thus, it might have benefited from including elements and exercises that emphasize the emotional aspects of the relational pathway, thereby strengthening it and promoting sustainable consumption.

4.2. Prediction of nutrition behavior measures

The exploratory cross-sectional results of our study revealed that the trait mindfulness facets "Acting with Awareness" and "Outer Awareness", in addition to explicit attitudes, significantly predicted the SCBN Score, indicating self-reported sustainable consumption behavior. Regarding vegetarian consumption behavior in the online supermarket task, sex and explicit attitudes were the only significant predictors. The relation of these specific mindfulness facets with sustainable consumption behavior aligns with prior research findings. For instance, the dimension "Outer Awareness" has been linked to explicit attitudes toward diverse sustainability-related objects and concepts in the study by Winkelmair et al. (2023). Additionally, "Acting with Awareness" demonstrated a direct correlation with self-reported sustainable food consumption in the research conducted by Hunecke and Richter (2019). Our results further emphasize the predictive significance of individuals' self-reported attitudes for consumption behavior based on analyses from cross-sectional data. Therefore, caution is advised when making causal inferences. This is consistent with previous research in the field of nutrition, which identifies attitudes as key variables in explaining actual behaviors (Bermdsen & Pligt, 2004). In terms of vegetarian purchasing behavior in the online supermarket task, sex also appeared to have a notable influence, consistent with prior research indicating that nutritional attitudes and eating habits may differ according to sex (Love &

Sulikowski, 2018).

4.3. Limitations

There are several limitations of our research that must be considered. First, this study is based on the premise that vegetarian nutrition represents a sustainable dietary choice, with individuals potentially opting for a vegetarian diet due to sustainability concerns. However, as previously noted, sustainable dietary practices encompass a range of options beyond vegetarianism. Additionally, individuals may adopt a vegetarian lifestyle for reasons beyond sustainability, such as moral convictions, health considerations, animal welfare, allergies, and more. Therefore, the association between mindfulness and sustainable consumption may not be universally applicable to this specific domain. Second, despite previous studies demonstrating the efficacy of online mindfulness interventions (e. g., Bossi et al., 2022), the online implementation of the intervention represents a significant deviation from prior research examining the relationship between mindfulness training and sustainability. Moreover, the online supermarket task represents a relatively new paradigm, and as such, there is currently no empirical data available on its correlation with actual purchasing behavior. This aspect presents an intriguing pathway for future research. Concerning the representativeness of our sample, it is important to acknowledge that nearly all participants were students of Applied Movement Science who received course credit as an incentive for their participation. Mindfulness might not be suitable for and resonate with everyone and could require a certain level of personal interest for individuals to internalize the concept. Lastly, since ten participants had to be manually reassigned from the IG to the CG, the group assignment was not entirely random. In [Supplementary Material B](#), we conducted analyses for our hypotheses excluding these ten participants. The results revealed no discrepancies in the findings for Hypotheses 1, 2, and 4. However, the significant interaction effect for trait mindfulness (Hypothesis 3) was no longer present. One possible explanation is that the reduced number of participants made it challenging to detect a small effect. This deviation in the results should be regarded as a limitation.

4.4. Conclusion

Our findings could not substantiate previous claims regarding the potential causal effects of mindfulness practice on sustainable consumption behavior, particularly within the context of sustainable and vegetarian nutrition, as well as subjective wellbeing. The relationship between mindfulness and sustainable behavior remains unclear. Future research could benefit from implementing longer-term mindfulness interventions with a greater focus on sustainability-related content, as understanding sustainability may be essential for inducing behavior change. The sample of this study consisted of both omnivorous and vegetarian/vegan individuals. Future research could gain insight by analyzing each dietary group separately to understand the composition of relative attitude measures. This would help determine if attitudes toward both vegetarian and meat-based foods change, thereby allowing for a more tailored intervention. Additionally, participants should engage in the intervention on a completely voluntary basis, demonstrating personal interest and receptiveness to the concept of mindfulness, along with a commitment to investing time for practice beyond the weekly sessions. Furthermore, qualitative analyses may provide additional insights alongside quantitative data analyses, as nutrition is a deeply personal and intricate construct that may not be fully captured solely through quantitative questionnaires. Lastly, it has been demonstrated that the feeling of connectedness seems to be important for sustainable behavior (Jansen, Hoja, & Rahe, 2024; Jansen, Rahe, & Wolff, 2024) - connectedness with nature and other humans, as investigated by the effects of prosocial behavior. Therefore, it might be worth investigating the effects of a connectedness training on attitudes and behaviors in the context of sustainable nutrition.

Funding

This research was financially supported by EDEN foundation (Im Stifterverband für die Deutsche Wissenschaft; Barkhovenallee 1 45239 Essen), grand ID S0289/10048/20. There was no involvement in study design, collection, analysis, and interpretation of data, or writing of the manuscript.

Ethical statement

We declare that the research underlying the following manuscript was approved by the ethical committee of the University of Regensburg (reference number: 20–1978 2-101) and has been conducted conforming to the ethical standard laid down in the 1964 Declaration of Helsinki: Can mindfulness-based training impact explicit and implicit attitudes and sustainable nutrition behavior? A focus on vegetarianism

All participants gave informed consent for participation in the study.

CRediT authorship contribution statement

Annica Winkelmaier: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Conceptualization. **Petra Jansen:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Annica Winkelmaier reports financial support was provided by Eden Stiftung. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The dataset generated and analyzed during the current study are available in the OSF repository: https://osf.io/x9jaq/?view_only=8f726028eeb34c0582a623b65ba174c3.

Acknowledgments

We extend our gratitude to Dr. Carmen Jochem and her team for organizing and leading the workshop on sustainable nutrition. Additionally, we would like to express our appreciation to Jens Blechert for supplying the visual materials used in the explicit and implicit attitude measurements. Lastly, we offer special thanks to our colleague Franziska Anna Schroter for her assistance with data preprocessing and the calculation of the permutation-based split-half reliability of the FT and the IAT.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2024.107554>.

References

- Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin*, *84*(5), 888–918. <https://doi.org/10.1037/0033-2909.84.5.888>
- Anderson, E. C., Wormwood, J., Barrett, L. F., & Quigley, K. S. (2019). Vegetarians' and omnivores' affective and physiological responses to images of food. *Food Quality and Preference*, *71*, 96–105. <https://doi.org/10.1016/j.foodqual.2018.06.008>
- Baer, R., Crane, C., Montero-Marin, J., Phillips, A., Taylor, L., Tickell, A., et al., The MYRIAD team. (2021). Frequency of self-reported unpleasant Events and harm in a mindfulness-based program in two general population samples. *Mindfulness*, *12*(3), 763–774. <https://doi.org/10.1007/s12671-020-01547-8>

- Barnes-Holmes, D., Murtagh, L., Barnes-Holmes, Y., & Stewart, I. (2010). Using the implicit association test and the implicit relational Assessment procedure to measure attitudes toward meat and vegetables in vegetarians and meat-Eaters. *Psychological Record*, *60*(2), 287–305. <https://doi.org/10.1007/BF03395708>
- Beattie, G., & McGuire, L. (2012). See no evil? Only implicit attitudes predict unconscious eye movements towards images of climate change. *Semiotica*, *2012* (192), 315–339. <https://doi.org/10.1515/sem-2012-0066>
- Bergomi, C., Tschacher, W., & Kupper, Z. (2014). Konstruktion und erste Validierung eines Fragebogens zur umfassenden Erfassung von Achtsamkeit: Das Comprehensive Inventory of Mindfulness Experiences. *Diagnostica*, *60*(3), 111–125. <https://doi.org/10.1026/0012-1924/a000109>
- Berndsen, M., & Pligt, J. van der (2004). Ambivalence towards meat. *Appetite*, *42*(1), 71–78. [https://doi.org/10.1016/S0195-6663\(03\)00119-3](https://doi.org/10.1016/S0195-6663(03)00119-3)
- Beshara, M., Hutchinson, A. D., & Wilson, C. (2013). Does mindfulness matter? Everyday mindfulness, mindful eating and self-reported serving size of energy dense foods among a sample of South Australian adults. *Appetite*, *67*, 25–29. <https://doi.org/10.1016/j.appet.2013.03.012>
- Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., et al. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice*, *11*(3), 230–241. <https://doi.org/10.1093/clipsy.bph077>
- Blechert, J., Lender, A., Polk, S., Busch, N. A., & Ohla, K. (2019). Food-Pics_Extended—an image database for experimental research on eating and Appetite: Additional images, normative ratings and an Updated review. *Frontiers in Psychology*, *10*, 307. <https://doi.org/10.3389/fpsyg.2019.00307>
- Bossi, F., Zaninotto, F., D'Arcangelo, S., Lattanzi, N., Malizia, A. P., & Ricciardi, E. (2022). Mindfulness-based online intervention increases well-being and decreases stress after Covid-19 lockdown. *Scientific Reports*, *12*(1), 6483. <https://doi.org/10.1038/s41598-022-10361-2>
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. <https://doi.org/10.1037/0022-3514.84.4.822>
- Cameron, C. D., Brown-Iannuzzi, J. L., & Payne, B. K. (2012). Sequential priming measures of implicit social cognition: A meta-analysis of associations with behavior and explicit attitudes. *Personality and Social Psychology Review*, *16*(4), 330–350. <https://doi.org/10.1177/1088868312440047>
- De Houwer, J., & De Bruycker, E. (2007). Implicit attitudes towards meat and vegetables in vegetarians and nonvegetarians. *International Journal of Psychology*, *42*(3), 158–165. <https://doi.org/10.1080/00207590601067060>
- Ericson, T., Kjønstad, B., & Anders, B. (2014). Mindfulness and sustainability. *Ecological Economics*, *104*, 73–79. <https://doi.org/10.1016/j.ecolecon.2014.04.007>
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. <https://doi.org/10.3758/BF03193146>
- Fischer, D., Stanzus, L., Geiger, S. M., Grossman, P., & Schrader, U. (2017). Mindfulness and sustainable consumption: A systematic literature review of research approaches and findings. *Journal of Cleaner Production*, *162*, 544–558. <https://doi.org/10.1016/j.jclepro.2017.06.007>
- Frank, P., Heimann, K., Kolbe, V., & Schuster, C. (2022). Can guided introspection help avoid rationalization of meat consumption? Mixed-Methods results of a pilot experimental study. *Cleaner and Responsible Consumption*, *6*, Article 100070. <https://doi.org/10.1016/j.clrc.2022.100070>
- Geiger, S. M., Fischer, D., & Schrader, U. (2018). Measuring what Matters in sustainable consumption: An integrative framework for the selection of relevant behaviors. *Sustainable Development*, *26*(1), 18–33. <https://doi.org/10.1002/sd.1688>
- Geiger, S. M., Fischer, D., Schrader, U., & Grossman, P. (2020). Meditating for the Planet: Effects of a mindfulness-based intervention on sustainable consumption behaviors. *Environment and Behavior*, *52*(9), 1012–1042. <https://doi.org/10.1177/0013916519880897>
- Geiger, S. M., Grossman, P., & Schrader, U. (2019). Mindfulness and sustainability: Correlation or causation? *Current Opinion in Psychology*, *28*, 23–27. <https://doi.org/10.1016/j.copsyc.2018.09.010>
- Glasman, L., Albarracín, D., & Glasman, L. R. (2006). Forming attitudes that predict future behavior: A metaanalysis of the attitude-behavior relation. *Psychological Bulletin*, *778*–822.
- Greenwald, A. G., Brendl, M., Cai, H., Cvencek, D., Dovidio, J. F., Frieze, M., et al. (2022). Best research practices for using the implicit association test. *Behavior Research Methods*, *54*(3), 1161–1180. <https://doi.org/10.3758/s13428-021-01624-3>
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, *74*, 1464–1480. <https://doi.org/10.1037/0022-3514.74.6.1464>
- Grossman, P. (2015). Mindfulness: Awareness informed by an Embodied ethic. *Mindfulness*, *6*(1), 17–22. <https://doi.org/10.1007/s12671-014-0372-5>
- Hargreaves, S. M., Raposo, A., Saraiva, A., & Zandonadi, R. P. (2021). Vegetarian diet: An overview through the perspective of quality of life domains. *International Journal of Environmental Research and Public Health*, *18*(8). <https://doi.org/10.3390/ijerph18084067>. Article 8.
- Hausler, M., Huber, A., Strecker, C., Brenner, M., Höge, T., & Höfer, S. (2017). Validierung eines Fragebogens zur umfassenden Operationalisierung von Wohlbefinden. *Diagnostica*, *63*(3), 219–228. <https://doi.org/10.1026/0012-1924/a000174>
- Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and Neural perspective. *Perspectives on Psychological Science*, *6*(6), 537–559. <https://doi.org/10.1177/1745691611419671>

- Hunecke, M., & Richter, N. (2019). Mindfulness, construction of meaning, and sustainable food consumption. *Mindfulness*, 10(3), 446–458. <https://doi.org/10.1007/s12671-018-0986-0>
- Jansen, P., Hoja, S., & Rahe, M. (2024). The relationship between the aspects of connectedness and sustainable consumption. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1216944>
- Jansen, P., Rahe, M., & Wolff, F. (2024). How does mindfulness relate to sustainable attitude and behavior? The role of possible mediators. *Current Psychology*. <https://doi.org/10.1007/s12144-024-05741-y>
- Kabat-Zinn, J. (1990). *Full Catastrophe living: Using the Wisdom of Your body and mind to Face stress, Pain, and Illness*. Delacorte.
- Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, 10(2), 144–156. <https://doi.org/10.1093/clipsy.bpg016>
- Kasser, T. (2017). Living both well and sustainably: A review of the literature, with some reflections on future research, interventions and policy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical & Engineering Sciences*, 375(2095), Article 20160369. <https://doi.org/10.1098/rsta.2016.0369>
- Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—a meta-analysis. *Global Environmental Change*, 23(5), 1028–1038. <https://doi.org/10.1016/j.gloenvcha.2013.05.014>
- Lange, K., Kühn, S., & Filevich, E. (2015). "Just another Tool for online studies" (JATOS): An Easy Solution for Setup and Management of Web Servers supporting online studies. *PLoS One*, 10(6), Article e0130834. <https://doi.org/10.1371/journal.pone.0130834>
- Love, H. J., & Sulikowski, D. (2018). Of meat and men: Sex differences in implicit and explicit attitudes toward meat. *Frontiers in Psychology*, 9. <https://www.frontiersin.org/articles/10.3389/fpsyg.2018.00559>
- Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, 44(2), 314–324. <https://doi.org/10.3758/s13428-011-0168-7>
- Medlicott, E., Phillips, A., Crane, C., Hinze, V., Taylor, L., Tickell, A., et al. (2021). The mental health and wellbeing of university students: Acceptability, effectiveness, and mechanisms of a mindfulness-based course. *International Journal of Environmental Research and Public Health*, 18(11). <https://doi.org/10.3390/ijerph18116023>. Article 11.
- O'Brien, R. M. (2007). A caution regarding Rules of Thumb for variance inflation factors. *Quality and Quantity*, 41(5), 673–690. <https://doi.org/10.1007/s11135-006-9018-6>
- Panzone, L., Hilton, D., Sale, L., & Cohen, D. (2016). Socio-demographics, implicit attitudes, explicit attitudes, and sustainable consumption in supermarket shopping. *Journal of Economic Psychology*, 55, 77–95. <https://doi.org/10.1016/j.joep.2016.02.004>
- Park, C. L., Riley, K. E., & Braun, T. D. (2016). Practitioners' perceptions of yoga's positive and negative effects: Results of a National United States survey. *Journal of Bodywork and Movement Therapies*, 20(2), 270–279. <https://doi.org/10.1016/j.jbmt.2015.11.005>
- Remmers, C., Topolinski, S., & Koole, S. L. (2016). Why being mindful may have more benefits than you realize: Mindfulness Improves both explicit and implicit mood regulation. *Mindfulness*, 7(4), 829–837. <https://doi.org/10.1007/s12671-016-0520-1>
- Riordan, K. M., MacCooon, D. G., Barrett, B., Rosenkranz, M. A., Chungyalpa, D., Lam, S. U., et al. (2022). Does meditation training promote pro-environmental behavior? A cross-sectional comparison and a randomized controlled trial. *Journal of Environmental Psychology*, 84, Article 101900. <https://doi.org/10.1016/j.jenvp.2022.101900>
- Rosenberg, E. L. (2004). Mindfulness and consumerism. In *Psychology and consumer culture: The struggle for a good life in a materialistic world* (pp. 107–125). American Psychological Association. <https://doi.org/10.1037/10658-007>
- Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and Eudaimonic well-being. *Annual Review of Psychology*, 52(1), 141–166. <https://doi.org/10.1146/annurev.psych.52.1.141>
- Ryan, R. M., Huta, V., & Deci, E. L. (2008). Living well: A self-determination theory perspective on eudaimonia. *Journal of Happiness Studies*, 9(1), 139–170. <https://doi.org/10.1007/s10902-006-9023-4>
- Rydell, R. J., & McConnell, A. R. (2006). Understanding implicit and explicit attitude change: A systems of reasoning analysis. *Journal of Personality and Social Psychology*, 91(6), 995–1008. <https://doi.org/10.1037/0022-3514.91.6.995>
- Ryff, C. D., Boylan, J. M., & Kirsch, J. A. (2021). Eudaimonic and hedonic well-being: An integrative perspective with Linkages to Sociodemographic factors and health. In M. T. Lee, L. D. Kubzansky, & T. J. VanderWeele (Eds.), *Measuring well-being* (1st ed., p. 92). York: Oxford University Press. <https://doi.org/10.1093/oso/9780197512531.003.0005>. C4.P285.
- Stanzus, L. S., Frank, P., & Geiger, S. M. (2019). Healthy eating and sustainable nutrition through mindfulness? Mixed method results of a controlled intervention study. *Appetite*, 141, Article 104325. <https://doi.org/10.1016/j.appet.2019.104325>
- Steiner, G., Geissler, B., Schreder, G., & Zenk, L. (2018). Living sustainability, or merely pretending? From explicit self-report measures to implicit cognition. *Sustainability Science*, 13(4), 1001–1015. <https://doi.org/10.1007/s11625-018-0561-6>
- Su, R., Tay, L., & Diener, E. (2014). The development and Validation of the comprehensive inventory of Thriving (CIT) and the brief inventory of Thriving (BIT). *Applied Psychology: Health and Well-Being*, 6(3), 251–279. <https://doi.org/10.1111/aphw.12027>
- Thiermann, U. B., & Sheate, W. R. (2020). Motivating individuals for social transition: The 2-pathway model and experiential strategies for pro-environmental behaviour. *Ecological Economics*, 174, Article 106668. <https://doi.org/10.1016/j.ecolecon.2020.106668>
- Thiermann, U. B., Sheate, W. R., & Vercammen, A. (2020). Practice Matters: Pro-environmental motivations and diet-related impact vary with meditation experience. *Frontiers in Psychology*, 11, Article 584353. <https://doi.org/10.3389/fpsyg.2020.584353>
- Vago, D. R., & Silbersweig, D. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, 6. <https://doi.org/10.3389/fnhum.2012.00296>
- Van't Riet, J., Sijtsema, S. J., Dagevos, H., & De Bruijn, G.-J. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite*, 57(3), 585–596. <https://doi.org/10.1016/j.appet.2011.07.010>
- Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. I. (2012). Climate change and food systems. *Annual Review of Environment and Resources*, 37(1), 195–222. <https://doi.org/10.1146/annurev-environ-020411-130608>
- Võ, M. L.-H., Conrad, M., Kuchinke, L., Urton, K., Hofmann, M. J., & Jacobs, A. M. (2009). The Berlin Affective word list Reloaded (BAWL-R). *Behavior Research Methods*, 41(2), 534–538. <https://doi.org/10.3758/BRM.41.2.534>
- Wamsler, C. (2019). Contemplative sustainable futures: The role of individual inner dimensions and transformation in sustainability research and education. In W. Leal Filho, & A. Consorte McCrea (Eds.), *Sustainability and the Humanities* (pp. 359–373). Springer International Publishing. https://doi.org/10.1007/978-3-319-95336-6_20
- Wamsler, C., Brossmann, J., Hendersson, H., Kristjansdottir, R., McDonald, C., & Scarampi, P. (2018). Mindfulness in sustainability science, practice, and teaching. *Sustainability Science*, 13, 143–162. <https://doi.org/10.1007/s11625-017-0428-2>
- Winkelmair, A., & Jansen, P. (2023). The positive impact of mindfulness interventions on the explicit and implicit affective attitudes toward vegetarian foods. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1158410>
- Winkelmair, A., Siebertz, M., Jost, L., Schroter, F. A., Bartenschlager, C. T. J., & Jansen, P. (2023). Explicit and implicit affective attitudes toward sustainability: The role of mindfulness, Heartfulness, connectedness to nature and Prosocialness. *International Journal of Applied Positive Psychology*, 8(3), 571–598. <https://doi.org/10.1007/s41042-023-00107-4>
- Zahedi, A., Öznur Akalin, R., Lawrence, J. E., Baumann, A., & Sommer, W. (2022). The nature and Persistence of Posthypnotic Suggestions' effects on food preferences: An online study. *Frontiers in Nutrition*, 9. <https://www.frontiersin.org/articles/10.3389/fnut.2022.859656>.