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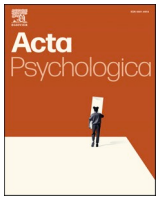

Affective and reflective attitudes toward vegetarian food consumption: The effect of imagery

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ABSTRACT

Objectives: The study's main goal was to investigate the effect of imagery on explicit and implicit attitudes toward vegetarian food consumption, as relevant psychological precursors of sustainable behavior in context of dual-process models.
Methods: 163 participants completed an explicit rating task and an implicit association test (IAT), respectively, at pre and post-intervention, namely a five-minute imagery task about vegetarian nutrition.
Results: The results showed, apart from explorative analyses, no significant time*group interaction effects on implicit attitudes, contrary to our initial expectation. There were no group differences in explicit attitudes toward vegetarian nutrition. Still, explicit attitudes toward meat-based nutrition got significantly worse in the intervention group than in the control group, which aligns with our initial expectations. Furthermore, eating habits moderated the effect between group and implicit attitudes significantly.
Conclusion: This study does not provide the full extent of the expected effect of imagery on altering explicit and implicit attitudes toward sustainable behavior, particularly vegetarian nutrition. Nevertheless, it shows promising imagery approaches as a short-term intervention promoting food-related attitudes as precursors of sustainable behavior in terms of stabilizing high implicit attitudes toward vegetarian nutrition and weakening explicit attitudes toward meat-based nutrition.

1. Introduction

Individual human behavior significantly contributes to environmental challenges and socioenvironmental crises (Stern, 2011). Sustainable behavior, or pro-environmental or environmentally friendly behavior, defined as actions that consciously minimize negative impacts on the natural and built environment (Kollmuss & Agyeman, 2002), is crucial for addressing these issues. Food production and consumption of food significantly influence greenhouse emissions, and CO2 can be reduced by abstaining from meat consumption (Vermeulen et al., 2012; Willett et al., 2019). Furthermore, animal production requires vast energy and water resources, contributing to deforestation, overgrazing, and overfishing (Leitzmann, 2003). Beyond ecological concerns, vegetarian nutrition has health benefits, such as reduced risks of chronic diseases (Segovia-Siapco & Sabaté, 2019) and social advantages, as 40 % of the world's grain harvest is fed to animals, which would be enough to feed all hungry people of our planet (Leitzmann, 2003). Leitzmann (2003) emphasizes that sustainable nutrition should prioritize plant-based foods, aligning vegetarian nutrition with ecological, economic, social and health sustainability. While behavior change remains a long-term goal in this context, recent research has emphasized that such changes often rely on prior shifts in individual attitudes toward food (König et al., 2016). These attitudes, which can be both explicit (reflective, deliberate) and implicit (automatic, affective), shape not only conscious decision-making but also spontaneous tendencies and action impulses (Rothman et al., 2009). Accordingly, psychological interventions that aim to modify these attitudinal components, as mental imagery, represent a promising strategy for indirectly promoting sustainable consumption patterns (Hollands et al., 2016). Even in the absence of direct behavioral outcomes, attitude-based interventions can serve as a meaningful step toward sustainability goals by targeting the underlying psychological precursors of behavior. Imagery is a promising method to promote sustainable food consumption by influencing explicit and implicit attitudes toward vegetarian and meat-based nutrition (Blair et al., 2001; Markland et al., 2015). From a theoretical perspective, this approach aligns with the Affective-Reflective Theory (ART; Brand & Ekkekakis, 2018), a dual-process model which conceptualizes behavior as the result of two interacting systems: type-1

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processes based on automatic affective valuations, and type-2 processes based on deliberate reasoning. Both are shaped by prior experiences and associated evaluations. Within ART, implicit attitudes influence spontaneous affective action impulses, while explicit attitudes inform deliberate action plans. Consequently, changing attitudes, even in the short term, can alter behavioral tendencies over time, particularly if such interventions reinforce pre-existing positive associations or challenge negative ones (Gawronski & Sritharan, 2010).

1.1. Theoretical frameworks of sustainable behavior

Following Bamberg and Möser (2007), sustainable behavior is seen as a mixture of concern for other people and self-interest. While earlier frameworks focused on one of these aspects, such as pro-socially motivated models (e.g., the norm-activation model, Schwartz, 1977) or self-driven models (e.g., the theory of planned behavior, Ajzen, 1991), Klöckner and Blöbaum's (2010) Comprehensive Action Determination Model (CADM) provides a more integrative approach, incorporating both normative influences (e.g., social norms, personal values) and rational, self-interested decision-making (e.g., perceived behavioral control, attitudes) into one cohesive framework. However, these models describe behavior because of an individual's rational decision based on their values (e.g., egoistic, altruistic, biospheric, or hedonistic values), attitudes, or intentions without considering that these individuals can also be unconsciously influenced by situational variables (Steg et al., 2014; Verplanken & Holland, 2002). While they acknowledge attitudes as part of the decision-making process, they often treat them as relatively stable precursors rather than dynamic targets of change. In contrast, interventions focusing directly on changing attitudes, both explicit and implicit, may represent a promising step toward long-term behavior change, particularly when guided by dual-process perspectives. To account for both conscious and non-conscious influences, dual-process theories such as the ART (Brand & Ekkekakis, 2018) propose that behavior results from the interplay between two distinct psychological systems: a fast, affect-based system (type-1) driven by automatic associations, and a slower, reflective system (type-2) based on deliberate reasoning and propositional thought (see also Kahneman, 2011; Stanovich & West, 2000). Central to ART is the idea that attitudes are not only predictors of behavior but also potential points of intervention. Implicit attitudes, formed through affective associations and prior experiences, influence spontaneous behavioral tendencies, while explicit attitudes contribute to reflective evaluations and decisions (Gawronski & Sritharan, 2010). Both systems are shaped by repeated exposure and can be modified through targeted psychological techniques. According to the ART, initially developed to explain and predict physical inactivity and exercise, the type-1 process is triggered by a stimulus and is defined by automatic associations to that stimulus and a resulting automatic affective valuation. This automatic affective valuation forms the basis for the reflective evaluation (type-2 process). The automatic affective valuation is connected to an action impulse and the reflective evaluation to an action plan (Brand & Ekkekakis, 2018). If there is an affective-reflective discrepancy and self-control resources are low, behavior is more likely to be determined by the affective type-1 process (Brand & Ekkekakis, 2018). Brand and Ekkekakis (2018) used the labels affective and reflective for type-1 and type-2 processes but equated these with other labels (e.g., type-1: implicit, associative, impulsive; type-2: explicit, propositional, rational). Guided mental imagery is one promising method for targeting both automatic and reflective evaluations. It can activate existing associations or generate new ones (Blair et al., 2001; Markland et al., 2015). Thus, imagery-based interventions may affect implicit and explicit attitudes in ways that align with the mechanisms described by ART, even if immediate behavioral outcomes are not measured. In the present study, we apply ART not to directly explain behavior, but to provide a theoretical rationale for targeting attitudinal components that may underlie future behavioral choices.

1.2. Imagery

Guided mental imagery is a multi-sensory, quasi-perceptual, and conscious experience that resembles the actual perception of some scene, event, or object but occurs without external stimuli, only in the mind's eye (Giacobbi et al., 2018). It has many of the same characteristics as an authentic experience, including causal sequences, concrete details, emotional arousal, and similar neurological characteristics (Kosslyn et al., 2001), meaning that the imagined events are processed by the brain in ways that closely mimic how real-life events are experienced. Therefore, it increases the accessibility of related cognitive, emotional, and behavioral representations (Markland et al., 2015) and has a more powerful impact on learning, decision making, and behavior compared with other methods of processing information. Literature shows, that imagery can empower sustainable behavior and sustainable food consumption through changing habits that hinder health-related behavioral change (Conroy & Hagger, 2018), changing thoughts and beliefs, such as reshaping pre-existing assumptions in handling challenges, organizing tasks, and maintaining motivation for sustainable practices (Duncan et al., 2011), modifying food consumption, diet and food cravings (Missbach et al., 2014; Morewedge et al., 2010; Tiggemann & Kemps, 2005), increasing connectedness to nature (Coughlan et al., 2022) and increasing the impact of beliefs and intentions to act pro-environmentally (Karlsson et al., 2024). In the present study, however, we do not assume that guided imagery directly changes behavior. Instead, we focus on its capacity to influence attitudes, psychological precursors of behavior, by activating affective and cognitive representations. More specifically, mental imagery can modify implicit attitudes by increasing the accessibility of automatic associations, especially when positive traces are already stored in memory. Provided pre-existing positive associations in memory, these contextual cues can elicit positive automatic associations triggering rapid changes in implicit attitude measures (Rydell & McConnell, 2010). Therefore, through increasing the accessibility of related cognitive, emotional and behavioral representations in memory, mental imagery, even though it is controlled and intentional, can moderate implicit processes. Thus, implicit processes serving as basis for explicit evaluations (Gawronski & Sritharan, 2010), mental guided imagery is one promising way of influencing implicit and explicit attitudes.

Several conditions have been identified that enhance the effectiveness of imagery-based attitudinal change, such as personal relevance, emotional involvement, vividness of the mental simulation, and consistency with pre-existing beliefs (Markland et al., 2015). In our study, participants were guided through a brief imagery task that invited them to imagine eating their favorite vegetarian meal while reflecting on its taste, texture, emotional impact, and ecological implications. Positive sensations were combined with informative content about vegetarian nutrition and critical facts about meat-based diets, delivered in a way that allowed for personal adaptation and internal visualization (Giacobbi et al., 2023; Williams et al., 2013).

Similar interventions have previously demonstrated positive outcomes. For instance, Coughlan et al. (2022) used guided imagery to strengthen participants' connectedness to nature, while Karlsson et al. (2024) increased pro-environmental intentions through vivid, emotionally involving visualization of nature protection scenarios. These findings support the potential of imagery to activate motivational and evaluative systems relevant to sustainable behavior via attitudinal pathways.

1.3. Explicit and implicit attitudes in sustainable behavior

Attitudes can be understood as our conscious or subconscious assessments of a situation. According to dual-process models, human behavior is influenced by both controlled (conscious) and automatic (unconscious) processes. These processes are shaped, among other factors, by explicit and implicit attitudes, which represent conscious and

automatic evaluations of specific objects, such as food (Morewedge & Kahneman, 2010; Sherman et al., 2014). While attitudes reflect an individual's evaluation of a concept or behavior, they are not equivalent to behavior itself. Instead, attitudes serve as psychological precursors that can influence behavior depending on contextual and motivational factors (Ajzen, 1991; Rothman et al., 2009). Explicit measurements, such as asking participants to evaluate vegetarian or meat-based food, can be used to measure attitudes that participants are aware of (type-2 process). Conversely, implicit measurements assess attitudes that participants are at least partially unaware of (type-1 process), like the Implicit Association Test (Greenwald et al., 1998).

1.4. The goal of the study

The goal of this study is to examine the effects of guided imagery focused on imagining a pleasant and informative vegetarian nutrition experience on affective and reflective attitudes toward vegetarian and meat-based nutrition, as such attitudes are known to shape food-related decisions (Rothman et al., 2009).

We investigate how guided imagery activating a pattern of positive automatic associations with vegetarian nutrition influences the explicit and implicit attitudes toward vegetarian and meat-based nutrition using an explicit rating task and an implicit association test (IAT; Greenwald et al., 1998). Blair et al. (2001) showed that implicit attitudes can be modified by brief imagery interventions and following ART (Brand & Ekkekakis, 2018); implicit attitudes are the basis of automatic associations, the central part of the unconscious type-1 process. Engaging in imagery can elicit positive automatic associations if there are pre-existing positive associations in memory, which can lead to rapid changes in implicit attitude measures (Rydell & McConnell, 2010). Therefore, we formulate the following hypothesis:

H1. Implicit attitudes toward vegetarian nutrition will become more positive for the intervention group than for the control group.

Reflective evaluations are based on automatic associations (Brand & Ekkekakis, 2018; Gawronski & Sritharan, 2010) in form of a default-interventionist model, in which the affective valuation is the default-response upon which the slower, controlled response is based. Furthermore, the vegetarian nutrition imagery is not only pleasant to induce positive automatic associations but also points out positive information about vegetarian nutrition, to influence propositions, like one's needs and values, pros and cons of behavioral change, beliefs, morals and social expectations to reach long-term goals, which are part of the type-2 process with explicit attitudes (Brand & Ekkekakis, 2018). Additionally, the imagery of the intervention group contains several negative facts about production and consumption of meat-based foods, also influencing propositions about meat-based nutrition.

While explicit attitudes are generally considered more stable and less susceptible to change than implicit attitudes (Wilson et al., 2000), previous research has shown that they can be influenced even by short interventions when the content is emotionally involving, personally relevant, and cognitively engaging (Blair et al., 2001). Moreover, negative framing has been found to elicit stronger cognitive and emotional responses than positive messaging, which can facilitate rapid change in evaluative judgments (Rozin & Royzman, 2001). Given that our imagery included emotionally salient and personally relevant health, environmental, and ethical information about meat consumption, we expected it to influence reflective evaluations. Therefore, we hypothesize:

H2. Explicit attitudes toward vegetarian nutrition will become more positive for the intervention group compared to the control group and explicit attitudes toward meat-based nutrition will become more negative for the intervention group compared to the control group.

According to the ART, automatic associations are retrieved from direct experiences (Fazio et al., 1995), learned pleasure, related propositions, and every activation of an association leaves traces in the associative network, which leads to a feedback loop with automatic affective valuation feeding into the controlled evaluation, which can be stored in memory and contribute to future automatic associations (Brand & Ekkekakis, 2018). Participants with more regular vegetarian nutrition may have more accessible positive automatic associations with vegetarian nutrition than participants with omnivore nutrition. Therefore, we formulate the following hypothesis:

H3. Nutrition status (vegetarian versus omnivore) moderates the effects of imagery on implicit and explicit attitudes, with a more significant effect among vegetarians.

2. Method

We aim to investigate the impact of imagery on the explicit and implicit attitudes toward vegetarian and meat-based nutrition. Hence, a 2 (vegetarian nutrition imagery, comparison neutral audio script) x 2 (pre-intervention, post-intervention) design will be applied. The participants will complete a test before the intervention (pre-test), including – in the following order – a demographic questionnaire, the explicit evaluation task, and the implicit association test. Afterward, the participants read a short script describing the nature of imagery and approximately 5 min guided imagery dependent on their group with a manipulation check, followed by the same reflective and affective evaluation tasks at post-intervention.

2.1. Participants

For an appropriate sample size for H1 and H2, a power analysis, calculated using G*power (Faul et al., 2007), for a repeated measures ANOVA with the within-factor time (pre/post) and between-factor condition (experimental imagery/comparison imagery), a small effect size of $f = 0.15$, an alpha-level of 0.05, a power of $1\text{-}\beta = 0.95$ and a correlation among repeated measurements of 0.5 resulted in $N = 148$ to detect significant differences between the condition experimental imagery or comparison audio script in explicit on the one side and implicit attitudes on the other side toward images of vegetarian and meat-based nutrition.

For an appropriate sample size for H3, a power analysis using G*power (Faul et al., 2007) for a moderation analysis with a linear multiple regression with fixed model, R^2 increase with effect size of $f^2 = 0.02$, an alpha-level of 0.05, a power of $1\text{-}\beta = 0.95$, 1 tested predictor (nutrition status) and three total predictors (experimental imagery, nutrition status and pre-scores of implicit or explicit attitudes) resulted in $N = 652$ to detect significant moderation effects of nutrition status on explicit on the one side and implicit attitudes on the other side. To keep the sample size in a realistic extent of $N = 148$, calculated for H1 and H2, we repeated the power analysis with a linear multiple regression fixed model, R^2 increase with an alpha-level of 0.05, a power of $1\text{-}\beta = 0.95$, 1 tested predictor (nutrition status) and three total predictors (experimental imagery, nutrition status and pre-scores of implicit and explicit attitudes) and came to the result, that for the aimed sample size, there is a possible effect size of $f^2 = 0.089$, which will be used in this study due to feasibility. We expected a dropout rate of approximately 10 %. Therefore, the estimated sample size of 148 was increased to 163 subjects, which served as the maximum sample size.

All participants were randomly assigned to one of the two groups (experimental imagery, comparison neutral imagery), resulting in equally distributed sample sizes for the groups. The study was conducted following the principles of the Helsinki Declaration regarding ethical guidelines and was approved by the Ethical Board of the University of Regensburg (reference number: 20-1978_2-101).

The population was all students of applied movement science from the University of Regensburg, at least 18 years old, recruited via social media or the institute's newsletter and gaining study credits for their

participation.

2.2. Material

In this study, a demographic questionnaire, an explicit affective evaluation, implicit association task and an imagery task in form of a guided imagery through audio script were applied.

2.2.1. Demographic questionnaire

Participants answered questions concerning sex, age, education stage, importance of nutrition, (importance of sustainable nutrition) and eating habits (vegan, vegetarian, omnivorous).

2.2.2. Explicit evaluation task

For the explicit rating task, five pictures of meat-containing food and five pictures of vegetarian food were chosen from the database of Blechert et al. (2019) and matched in familiarity, arousal, and valence. The explicit evaluation rating task consisted of the following question: "How much do you like the food in the photo?" (1 = "very much", 7 = "not at all"). Participants had five seconds to respond. Indices are calculated by the mean score of explicit rating for each category (meat and vegetarian products).

2.2.3. Implicit association task

The standard IAT was chosen to assess the implicit attitudes (Greenwald et al., 1998). The IAT used in this study was adapted from the version of Winkelmair and Jansen (2024). It comprises four categories, two target and two attribute categories, and various stimuli, target images, and attribute words. As target categories, "vegetarian" and "meat" will be used, and as attribute categories, "positive" and "negative." As target images and attribute words, we will use the same ten pictures of vegetarian or meat-based foods as in the explicit affective evaluation and five positive and five negative words of the Berlin affective word list (Võ et al., 2009).

In each trial, the participant is told to sort a stimulus, presented in the center of the screen, to the respective category by pressing "D" for the category on the left or "K" for the category on the right. In blocks 1 and 5, the participant sorts only target images into the respective target categories ("vegetarian" or "meat"), which are presented in black font on the upper left and right side of the screen. In block 2, attribute stimulus words are sorted to the respective category ("positive" or "negative"), presented in green font on the upper left or right of the screen. Blocks 3, 4, 6, and 7 are combined blocks with two categories (one target category in black font and one attribute category in green font) presented on each side (see Fig. 1). Target images appear in odd-numbered trials, and attribute words in even-numbered trials. Each stimulus belongs to only one category and must be sorted accordingly. If the participant presses the wrong key, a red cross will be shown under the stimulus until the correct key gets pressed. The sides on which the target and attribute categories appear is randomized across the participants. In block 5, the sides of the target categories will be swapped and maintained over the remaining blocks.

An index of the implicit attitudes will be calculated via D-Score. The procedure of Greenwald et al. (2022) will be used to calculate the D-Score. Latency means, and standard deviations of the combined blocks will be computed. The difference between the means of the blocks (blocks where quicker responses yield a negative score – blocks where quicker responses yield a positive score) will be separately computed for long and short blocks. Additionally, an inclusive pooled standard deviation will be established for shorter and longer blocks. The difference in mean scores for the short blocks will be divided by its standard deviation, and the same procedure will be applied for the long blocks. Finally, the resulting scores will be averaged to derive the D-Score. Following Greenwald et al. (2022), all trials from blocks 1,2 and 5 are discarded. Furthermore, trials with response times >10.000 ms are excluded, and participants with more than 10 % response times below 300 ms are excluded from the analysis.

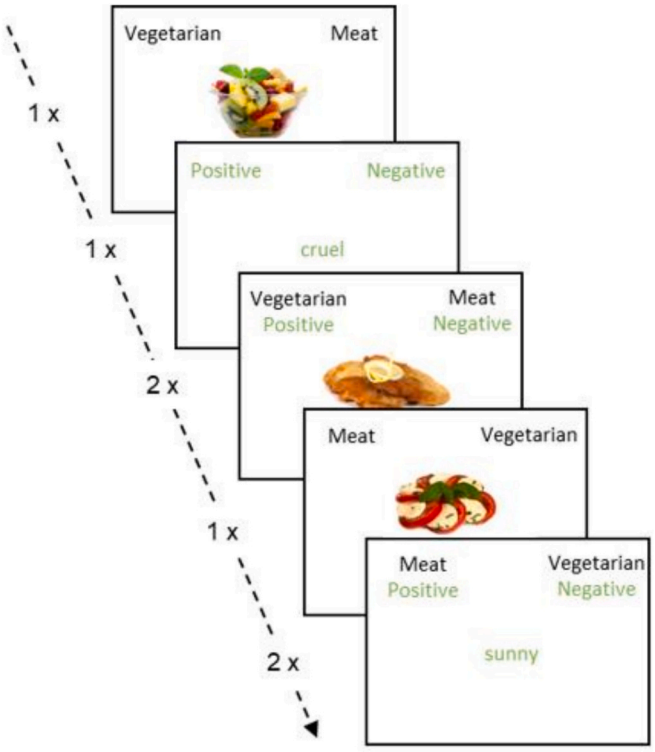

Fig. 1. Experimental setting of the implicit association test.

2.3. Imagery task

Participants listen to an approximately 5-min audio-recorded imagery script, which guides the participants to focus on positive sensations and informative pro-environmental facts associated with vegetarian nutrition and critical facts about the production of meat-based foods while imagining eating their favorite vegetarian meal. The script, developed by the recommendations provided by Williams et al. (2013) and Giacobbi et al. (2023), is meant to be specific enough that the participants will be inspired but still vague enough that they can personalize the imagery experience. Concordant to the experimental imagery, participants of the control group listened to an approximately 5-min audio script but with no intention of inducing positive sensations or learning about vegetarian or meat-based nutrition. This audio script is about the history of the Stone Bridge, a well-known sight in Regensburg.

2.4. Procedure

The experiment lasted 30 min and was conducted using the programs OpenSesame (Mathôt et al., 2012) and SoSci (Leiner, 2019). The participants started with the explicit affective evaluation and then conducted the implicit association task. After these tests, the imagery took place, followed by the second conduct of explicit and implicit tasks, both identical to the first ones. After finishing this part of the experiment in OpenSesame, the participants completed the demographic questionnaire set up using SoSci.

2.5. Statistical analysis

Hypotheses and the analytic plan were specified before data collection in the preregistration at OSF: osf.io/gahx8. Deviations from the preregistration are marked. Descriptively, demographic variables, e.g., age and gender distributions, are reported. Furthermore, variables interesting for our present study, such as the numbers of vegetarians,

vegans, and omnivores and the general importance of their nutrition, are reported.

To test if there are significant differences in implicit on the one side and explicit attitudes on the other side toward images of vegetarian and meat-based nutrition, repeated measure ANOVAs were conducted, each individual for the dependent variables implicit and explicit attitude (H1 and H2) and the independent variables group (between, experimental imagery vs comparison audio script) and time (within, pre vs post). Repeated measures factors are in each case pre and post and the between-subject factor group. ANOVAs were followed by post hoc independent samples *t*-tests. To test H3, if nutrition status moderates the expected effects of imagery on implicit on the one side and explicit attitudes on the other side toward images of vegetarian and meat-based nutrition, we conducted a moderation analysis using the PROCESS macro by Hayes (2018), which uses ordinary least squares regression, each individual for the dependent variables post-scores implicit and explicit attitude, the independent variable condition (experimental imagery/comparison audio script) and the tested predictor interaction of group and nutrition status.

Exploratory analyses were conducted with divided data based on participants' implicit attitudes toward vegetarian nutrition at pre-testing, using the median as the cut-off point. One group had implicit attitudes greater than the median, while the other had attitudes lower than the median. Subsequently, all analyses were performed separately for each group with interesting findings concerning H1.

3. Results

3.1. Demographic data

There is a statistical difference between men and women regarding age ($t(161) = 2.08$, $p = .040$), but no significant difference for the importance of nutrition ($t(161) = -0.96$, $p = .341$) and the importance of sustainable nutrition ($t(161) = -1.88$, $p = .061$). There is a significant relation between gender and eating habits ($\chi^2(1) = 11.61$, $p < .001$), with women's eating behavior being more often vegetarian but less omnivore than men's (see Table 1).

3.2. Manipulation checks of transcription task

Descriptives of the manipulation check of the transcription task, shown in Table 2, show a significant difference in ease of using all senses ($t(161) = -5.85$, $p < .001$), but no significant differences in clarity ($t(161) = -1.26$, $p = .105$), ease of feeling ($t(161) = -0.80$, $p = .420$) and information processing ($t(161) = -1.94$, $p = .054$) between the two groups.

3.3. Implicit attitudes toward vegetarian nutrition

The data had no outliers, and the groups were normally distributed. Implicit attitudes toward vegetarian nutrition were highest in the intervention group at post-intervention (M = 2.20., SD = 4.01) and lowest in the control group at post-intervention (M = 1.27., SD = 4.05). Implicit attitudes at pre-intervention were higher in the intervention group (M = 1.93., SD = 4.40) than in the control group (M = 1.78., SD = 4.44).

A repeated measures ANOVA (see Table 3) showed no statistically significant difference for time, $F(1, 161) = 0.26$, $p = .611$, group, $F(1, 161) = 0.77$, $p = .382$, and no significant difference for the interaction between time and group, $F(1, 161) = 2.52$, $p = .114$ in implicit attitudes toward vegetarian nutrition.

Exploratory, a repeated measures ANOVA (see Table 3) determined that implicit attitudes toward vegetarian nutrition of half of the participants with already high implicit ratings (higher than Median) showed a statistically significant difference for time, $F(1, 161) = 22.21$, $p < .001$, and statistically significant difference for the interaction between time and group (i.e., participants with implicit attitudes pre-test ratings above the median in the intervention group vs. control group), $F(1, 161) = 5.55$, $p < .001$, indicating that implicit attitudes toward vegetarian nutrition changed over time and that these changes differed between groups. The independent samples *t*-tests revealed a significant difference in the above median intervention group between the pre-ratings (M = 5.11, SD = 2.01) and the post-ratings (M = 4.41, SD = 2.41), $t(45) = 2.05$, $p = .023$. It also showed a significant but higher loss in the control group between the pre-ratings (M = 5.96, SD = 2.38) and the post-ratings (M = 3.85, SD = 3.43), $t(34) = 4.09$, $p < .001$.

A comparison of the two groups revealed a significant difference in their changes over time, with the post-test ratings in the above median intervention group showing a smaller decrease compared to the control group. This difference between groups was statistically significant ($t(79) = -2.356$, $p = .010$).

3.4. Explicit attitudes toward vegetarian and meat-based nutrition

The data had no outliers, and the groups were normally distributed. Explicit attitudes toward vegetarian nutrition were higher at post-intervention than at pre-intervention, both in the intervention group (pre: M = 5.48., SD = 0.80; post: M = 5.63., SD = 0.83) and in the control group (pre: M = 5.30., SD = 1.02; post: M = 5.42., SD = 1.06).

Vegetarian nutrition: Using a RM ANOVA (see Table 4) with the dependent variable explicit attitude toward vegetarian nutrition and the independent variables group and time, Table 4 shows that explicit

Table 1
Means (SD) of age, importance of nutrition, importance of sustainable nutrition and relative frequency of eating habits.

	Age	Importance nutrition	Importance sustainable nutrition	Eating habits
Men (*N* = 91)	23.22 (4.34)	5.62 (0.92)	4.75 (1.27)	Omnivore: 84.6 % Vegetarian: 15.4 %
Women (*N* = 72)	21.93 (3.35)	5.76 (1.07)	5.10 (1.05)	Omnivore: 61.1 % Vegetarian: 38.9 %

Table 2
Means (SD) of the manipulation check of the imagery task (clarity, ease of feelings, ease of other senses, ease of information processing).

	Clarity	Feeling	Senses	Information processing
Vegetarian imagery (*N* = 82)	5.62 (1.02)	4.61 (1.39)	4.33 (1.44)	5.80 (0.95)
Comparison imagery (*N* = 81)	5.40 (1.26)	4.43 (1.42)	3.09 (1.27)	5.47 (1.25)

Table 3
RM ANOVAs with the dependent variables implicit attitude toward vegetarian nutrition (Imp_Veg) and implicit attitudes toward vegetarian nutrition of participants with implicit attitudes higher than the median (Imp_Veg > Med) and independent variables group and time.

		df	F	p
Imp_Veg	Group	1	0.768	0.382
	Time	1	0.260	0.611
	Time * group	1	2.524	0.114
Imp_Veg > Med	Group	1	0.094	0.760
	Time	1	22.207	<0.001
	Time * group	1	5.552	0.021

Table 4
RM ANOVA with the dependent variable explicit attitude toward vegetarian nutrition and independent variables group and time.

	df	F	p
Group	1	1.886	0.172
Time	1	11.805	<0.001
Time * group	1	0.121	0.729

attitudes toward vegetarian nutrition showed a statistically significant difference between pre and post-measurements, $F(1, 161) = 11.81$, $p < .001$, but no statistically significant difference for group, $F(1, 161) = 1.89$, $p = .172$ and the interaction between time and group, $F(1, 161) = 0.12$, $p = .729$.

Meat-based nutrition: The data has no outliers, and the groups were normally distributed. Explicit attitudes toward meat-based nutrition were higher at pre-intervention than at post-intervention, both in the intervention group (pre: M = 3.83., SD = 1.73; post: M = 3.42., SD = 1.73) and in the control group (pre: M = 3.81., SD = 1.66; post: M = 3.70., SD = 1.63).

A RM ANOVA (see Table 5) with the dependent variable explicit attitude toward meat-based nutrition and the independent variables group and time determined that explicit attitudes toward meat-based nutrition showed a statistically significant difference for time, $F(1, 161) = 41.48$, $p < .001$, but not for group, $F(1, 161) = 0.24$, $p = .622$, and statistically significant difference for the interaction between time and group, $F(1, 161) = 13.73$, $p < .001$, indicating that explicit attitudes toward meat-based nutrition changed over time and that these changes differed between groups. The independent samples *t*-tests revealed a significant difference in the intervention group between the pre-ratings (M = 3.83, SD = 1.73) and the post-ratings (M = 3.42, SD = 1.73), $t(81) = 6.17$, $p < .001$. It also showed a significant, but smaller, difference in the control group between the pre-ratings (M = 3.81, SD = 1.66) and the post-ratings (M = 3.70, SD = 1.63), $t(81) = 2.42$, $p = .009$. The comparison of the two groups revealed a significant difference in their changes over time, with the post-ratings of explicit attitudes toward meat-based nutrition in the intervention group showing a larger decrease compared to the control group. This difference between groups was statistically significant ($t(161) = 3.93$, $p < .001$).

All descriptives and descriptives plots of explicit attitudes toward vegetarian and meat-based nutrition and implicit attitudes toward vegetarian nutrition, respectively at pre and post can be found in Table 6 and Fig. 2.

3.5. Eating habits as a mediator

Moderation analyses were performed using the PROCESS macro by Hayes (2018), which uses ordinary least squares regression, yielding unstandardized coefficients for all effects. Bootstrapping with 5000 samples together with heteroscedasticity consistent standard errors (HC3; Davidson & MacKinnon, 1993) were employed to compute the confidence intervals.

A moderation was run to determine whether the interaction between eating habits and conditions significantly predicts implicit attitudes toward nutrition. The overall model was significant, $F(3,159) = 13.98$, $p < .001$, predicting 15.09 % of the variance. Results show that eating habits (omnivore: $\beta = -6.12$, $p = .002$; vegetarian: $\beta = 5.31$, $p = .006$) moderated the effect between condition and implicit attitudes toward nutrition significantly, $\Delta R^2 = 1.66$ %, $F(1, 159) = 4.52$, $p = .035$, 95 % CI[−4.024, −0.032], indicating that the intervention had a more positive impact on implicit attitudes among vegetarians, whereas it had a smaller impact among omnivores.

Another moderation was run to determine whether the interaction between eating habits and conditions significantly predicts explicit attitudes toward vegetarian nutrition. The overall model was significant, $F(3,159) = 9.66$, $p < .001$, predicting 11.19 % of the variance. Analysis did not show that eating habits moderated the effect between condition and explicit attitudes toward vegetarian nutrition significantly, $\Delta R^2 = 1.37$ %, $F(1, 159) = 3.77$, $p = .054$, 95 % CI[−0.921, 0.009].

Another moderation was run to determine whether the interaction between eating habits and conditions significantly predicts explicit attitudes toward meat-based nutrition. The overall model was significant, $F(3,159) = 42.78$, $p < .001$, predicting 45.07 % of the variance. A moderation analysis was run to determine whether the interaction between eating habits and conditions significantly predicts explicit attitudes toward meat-based nutrition. The analysis did not show that eating habits moderated the effect between condition and explicit attitudes toward meat-based nutrition significantly, $\Delta R^2 = 0.07$ %, $F(1, 159) = 0.17$, $p = .680$, 95 % CI[−0.632, −0.988].

Table 5
RM ANOVA with the dependent variable explicit attitude toward meat-based nutrition and independent variables group and time.

	df	F	p
Group	1	0.243	0.622
Time	1	41.484	<0.001
Time * group	1	13.732	<0.001

Table 6
Descriptives of implicit attitudes toward vegetarian nutrition (Imp_Veg), implicit attitudes toward vegetarian nutrition of participants with implicit attitudes higher than the median (Imp_Veg > Med) and explicit attitudes toward vegetarian (Exp_Veg) and meat-based nutrition (Exp_Meat).

	Time	Group	N	Mean	SD
Imp_Veg	Pre	Intervention	81	1.928	4.391
		Control	82	1.782	4.444
	Post	Intervention	81	2.195	4.014
		Control	82	1.264	4.051
Imp_Veg > Med	Pre	Intervention	46	5.111	2.010
		Control	35	5.964	2.381
	Post	Intervention	46	4.408	2.414
		Control	35	3.855	3.435
Exp_Veg	Pre	Intervention	81	5.476	0.795
		Control	82	5.296	1.021
	Post	Intervention	81	5.627	0.827
		Control	82	5.412	1.063
Exp_Meat	Pre	Intervention	81	3.834	1.727
		Control	82	3.812	1.659
	Post	Intervention	81	3.422	1.725
		Control	82	3.701	1.629

4. Discussion

This study aimed to investigate changes in explicit and implicit attitudes toward vegetarian and meat-based nutrition through guided imagery focused on imagining a pleasant and informative vegetarian nutrition experience to support individual sustainable consumption behavior. Although our study did not measure behavior directly, the investigated attitudes are understood as relevant precursors of food-related actions, as established in prior dual-process models (Brand & Ekkekakis, 2018).

The results of our experiment show a protective function for high implicit attitudes toward vegetarian nutrition but no significant improvements for implicit attitudes toward vegetarian nutrition in general through guided imagery, contrary to Hypothesis 1. Also, guided imagery did not lead to more positive explicit attitudes toward vegetarian nutrition, contrary to Hypothesis 2. Still, it did lead to more negative explicit attitudes toward meat-based nutrition, in line with this part of Hypothesis 2. Eating habits moderated the effect between group and implicit attitudes toward vegetarian nutrition significantly with vegetarian eating habits improving implicit attitudes toward vegetarian nutrition. In contrast, omnivorous eating habits worsen them, in line

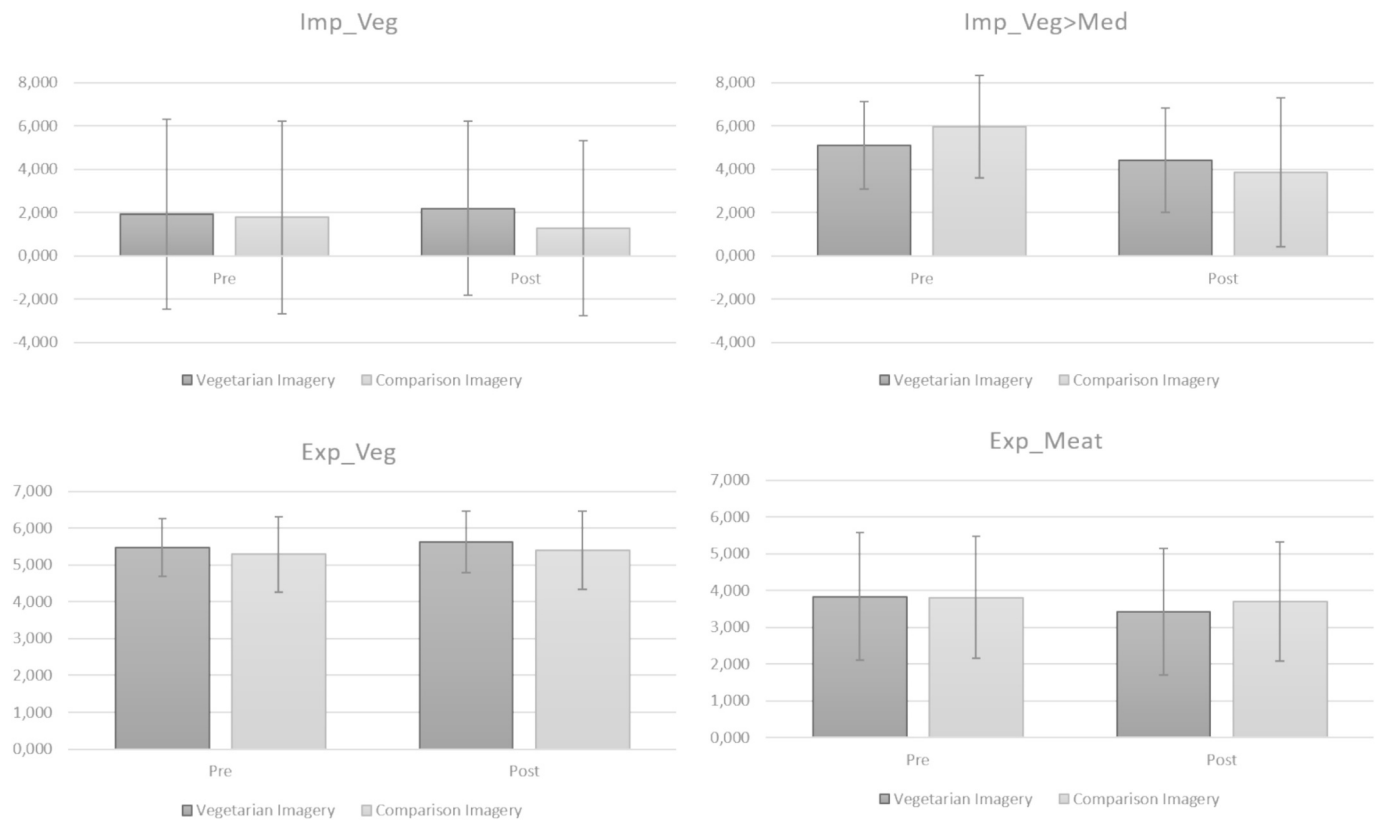

Fig. 2. Means (SE) of explicit attitudes toward vegetarian nutrition (Exp_Veg) and meat-based nutrition (Exp_Meat) and implicit attitudes toward vegetarian nutrition (whole sample: Imp_Veg; pre-values higher than Median: Imp_Veg > Med).

with H3. On the other hand, contrary to H3, eating habits did not significantly moderate the effect between group and explicit attitudes toward vegetarian and meat-based nutrition.

4.1. Imagery and implicit attitudes toward vegetarian nutrition

On the one hand, there was no statistically significant difference between different times and groups and no significant difference in the interaction between time and group in implicit attitudes toward vegetarian nutrition. This finding suggests that the imagery intervention alone may not modify implicit attitudes. According to the ART theory (Brand & Ekkekakis, 2018), implicit attitudes are strongly influenced by pre-existing automatic associations stored in memory. The lack of significant effects could indicate that the intervention failed to activate or create sufficiently strong new associations that could compete with or overwrite existing patterns. The limited duration of the intervention might not have been long enough to elicit meaningful changes in deeply ingrained implicit processes, particularly in participants without pre-existing positive attitudes toward vegetarian nutrition.

On the other hand, half of the participants with implicit ratings higher than the median of all participants showed a statistically significant difference for time and for the interaction between time and group (intervention group with implicit attitudes at pre-test higher than the median vs. control group), indicating that implicit attitudes toward vegetarian nutrition changed over time and that these changes differed between groups of pro-environmental imagery and control imagery with a significantly higher loss of implicit attitudes ratings toward vegetarian nutrition from pre to post ratings in the control group. The imagery intervention showed a protective effect on participants with high implicit attitudes toward vegetarian nutrition. These findings demonstrated that imagery interventions are particularly effective when participants already hold positive pre-existing associations related to the target behavior or concept (Rydell & McConnell, 2010). In this case, participants with higher baseline implicit attitudes toward vegetarian nutrition likely possessed more accessible cognitive and emotional representations of vegetarian nutrition in a more vivid and positive established way. The imagery intervention may have activated and reinforced these associations, leading to a measurable preservation of implicit attitudes. This aligns with the ART framework, which posits that contextual cues, such as imagery, can trigger patterns of automatic associations when these are already present in memory. Participants with lower baseline attitudes may not have had sufficient positive associations to be activated, limiting the intervention's effectiveness in these cases. According to Gawronski and Sritharan (2010), implicit attitudes are sensitive to contextual shifts and may weaken if not actively reinforced. The imagery intervention likely maintained the accessibility of positive associations with vegetarian nutrition, counteracting this natural decline. The protective effect emphasizes the potential of guided mental imagery for altering implicit attitudes, even if it does not significantly improve the overall sample.

4.2. Imagery and explicit attitudes toward vegetarian and meat-based nutrition

Explicit attitudes toward vegetarian nutrition showed a statistically significant difference in the time between pre- and post-measurements. Still, there was no statistically significant difference in the interaction between time and group. On the contrary, explicit attitudes toward meat-based nutrition showed a statistically significant difference for the time between pre and post-measurements and a statistically significant difference for the interaction between time and group, showing a significantly higher loss of explicit attitudes ratings from pre to post-measurements of meat-based nutrition in the group of pro-environmental imagery compared to the control imagery.

The missing significant interaction effect between time and group for explicit attitudes toward vegetarian nutrition could be explained by the

fact that participants already exhibited positive baseline attitudes toward vegetarian nutrition, notably higher than comparable studies (Barnes-Holmes et al., 2010; Houwer & Bruycker, 2007), leaving limited room for further enhancement. This aligns with the concept of a ceiling effect (Wang et al., 2008). The one-time short imagery intervention did not have the power to further significantly enhance explicit attitudes toward vegetarian nutrition.

On the other hand, the results highlight the effectiveness of the imagery intervention in influencing participants' reflective evaluations of meat consumption. The targeted use of negative information about meat-based nutrition within the imagery scripts likely triggered propositions on which reflective evaluations are based, like moral, environmental, value-based, and health-related considerations or long-term goals, leading to significant explicit attitude changes in the intervention group. This highlights the potential of guided imagery, even as a short-term and one-time intervention, for use in public health campaigns or educational programs to encourage sustainable nutrition. Imagery interventions can evoke strong emotional and cognitive responses, altering attitudes, aligning with sustainability goals and following ART, leading to sustainable behavioral change.

The decrease in explicit attitudes toward meat-based nutrition was more pronounced than the increase in explicit attitudes toward vegetarian nutrition, particularly in the intervention group. This asymmetry suggests that negative framing (e.g., highlighting the harms of meat consumption) had a stronger impact in reducing positive attitudes toward meat-based nutrition than positive framing (e.g., emphasizing the benefits of vegetarian nutrition) had in increasing positive attitudes toward vegetarian nutrition. Participants may have been more emotionally engaged by negative consequences of meat consumption, leading to a stronger shift in attitudes away from meat-based nutrition. This pattern aligns with the literature, which indicates that negative information often has a greater emotional impact and is more influential on decision-making than positive information (Rozin & Royzman, 2001). At the same time, it is worth noting that explicit attitude change can be hindered by resistance mechanisms such as message-induced reactance or pre-existing cognitive dissonance (Maio & Esses, 2001). However, the emotionally engaging and informative nature of our imagery intervention may have reduced such resistance by allowing participants to construct their own personalized and meaningful mental representations, rather than presenting them with overt persuasion.

Another consideration is the potential influence of social desirability on participants' responses in explicit attitude ratings. Given that sustainability and vegetarian diets are increasingly seen as morally and socially desirable choices, participants, particularly from a younger, educated population, may have reported more favorable views not due to true evaluative change but to align with perceived social norms (Braun et al., 2001). This could also explain why eating habits did not significantly moderate the group effect on explicit attitudes, as both vegetarians and omnivores may have expressed similarly favorable attitudes in line with dominant normative expectations. Future research should consider including measures of social desirability or use more indirect methods to assess explicit attitudes less prone to self-presentation bias.

4.3. The moderating role of eating habits in implicit and explicit attitudes toward vegetarian and meat-based nutrition

Eating habits moderated the effect between group and implicit attitudes toward vegetarian nutrition significantly, with vegetarian eating habits improving implicit attitudes toward vegetarian nutrition, while omnivorous eating habits worsened them. On the contrary, eating habits did not significantly moderate the effect between group and explicit attitudes toward vegetarian and meat-based nutrition.

Vegetarians' habitual engagement with plant-based diets likely results in more accessible positive automatic associations related to vegetarian nutrition. These associations were effectively activated and strengthened during the imagery intervention, reflecting the ART feedback loop where affective valuation feeds into reflective evaluation and contributes to future automatic associations (Brand & Ekkekakis, 2018). In contrast, omnivores may lack similar positive associations, which could make the intervention less impactful. Additionally, the intervention's emphasis on vegetarian nutrition may have created cognitive dissonance for omnivores, who may have perceived the content as incongruent with their dietary behaviors (Rothgerber, 2014).

Shared cultural and societal narratives promoting plant-based diets as sustainable and healthy may have led both vegetarians and omnivores to evaluate (explicit attitudes) vegetarian nutrition similarly (Gawronski & Sritharan, 2010). Furthermore, explicit attitudes toward vegetarian nutrition may already be well-established, particularly in a population of only sport students with high awareness of sustainability and healthy nutrition, no matter of being vegetarian or omnivorous, making them less malleable within the short timeframe of this intervention.

Also, a potential floor effect in vegetarians' explicit attitudes toward meat consumption could have contributed to the lack of significant moderation, as their baseline attitudes were already very low, leaving little room for further reduction.

4.4. Limitations and future research

As far as we know, this is the first study investigating the effect of a single-session imagery on the implicit and explicit attitudes toward sustainable nutrition in the context of ART (Brand & Ekkekakis, 2018). The RCT design offers several key advantages that strengthen the validity and reliability of the results.

A limitation of this study is the sample, which only consisted of students of Applied Movement Science. This narrow sample composition introduces a potential sampling bias, as students of Applied Movement Science are likely to be more informed about health and sustainability topics than the general population. As a result, their attitudes toward vegetarian nutrition may already reflect established positive evaluations, which limits the generalizability of the findings to broader or more diverse populations. This homogeneity may have contributed to ceiling effects in explicit attitude measures, especially among vegetarians. Additionally, participants showed very low explicit and implicit scores in support of meat-based nutrition, leading to a possible floor effect. These ceiling and floor effects likely reduced the sensitivity of our measurements and may have obscured potential shifts following the intervention. Future studies should aim to recruit more heterogeneous samples, from different educational backgrounds, age groups, and sociocultural contexts, to improve ecological validity and capture a wider range of baseline attitudes. In addition, self-reported explicit attitudes may have been influenced by demand characteristics or social desirability, particularly within a student sample highly aware of nutrition and sustainability topics.

Another limitation concerns the statistical power of our moderation analysis. Although we tested the moderating role of eating habits, our sample size ($N = 163$) fell short of the originally calculated target of $N = 652$ required to detect small interaction effects with sufficient power. As outlined in the Participants section, this limitation resulted from a reasoned adaptation of the power analysis to ensure feasibility while maintaining an adequate effect size for the tested model. However, the likelihood of Type II errors is increased, and the non-significant findings related to explicit attitudes should be interpreted with caution. Future research with larger samples is needed to confirm the stability and generalizability of these moderation effects.

Furthermore, even though the imagery script was specific enough to inspire the participants but vague enough that they could personalize the imagery experience, it still was the same script for every participant in the intervention group. Although the script allowed for some mental personalization by being deliberately open-ended, all participants in the intervention group were exposed to the same core content due to feasibility reasons. Prior research suggests that imagery becomes more

effective when it is tailored to personal values, preferences, or relevant experiences, as this can enhance emotional engagement and cognitive resonance (Blair et al., 2001). Future studies should therefore consider implementing individualized or semi-structured imagery tasks that draw on participants' own meaningful goals or motivations to strengthen both affective and reflective responses. The most significant effect of imagery, however, can be found in individualized imageries based on the personal preferences of each participant (Cumming et al., 2007). Tailoring the imagery to include relatable individual scenarios or providing additional individual contextual cues could help build initial positive associations.

While the present results demonstrate the short-term potential of the imagery intervention, the stability and persistence of these effects remain unclear. Since attitudes were measured only once immediately after the intervention, it remains uncertain whether the observed effects reflect temporary fluctuations or enduring changes. Moreover, the brief nature of the intervention, limited to a single five-minute session, may have been insufficient to alter deeply rooted implicit attitudes, particularly among participants without pre-existing positive associations toward vegetarian nutrition. Implicit evaluations are often rooted in long-standing experiences and memory traces, and research suggests they are most effectively shifted through repeated associative learning, as opposed to a single exposure (Kurdi & Banaji, 2017). Longitudinal studies are needed to investigate whether imagery can produce lasting changes in implicit and explicit attitudes. Additionally, repeated imagery sessions may create a cumulative effect, reinforcing existing positive associations, embedding them more deeply in memory, and creating new positive associations during the imagery. The more sessions employed, the more effective the imagery intervention (Simonsmeier et al., 2021). During initial imagery sessions, participants could begin forming new positive associations to vegetarian food, such as enjoyment, good taste, or satisfaction. These associations, once established, could become a cognitive and emotional resource that participants draw upon in subsequent sessions. This iterative process could strengthen both the automatic (type-1) and reflective (type-2) pathways described in the ART, resulting in more considerable, enduring changes in implicit and explicit attitudes.

5. Conclusion

This study investigated the effect of guided imagery on implicit and explicit attitudes toward vegetarian and meat-based nutrition, focusing on attitudinal change as a relevant precursor of sustainable consumption behavior. While the results did not show a significant overall improvement in implicit attitudes toward vegetarian nutrition through imagery, they did show a protective effect among participants with higher baseline implicit attitudes toward vegetarian nutrition. This highlights the role of pre-existing positive associations and, consequently, the potential added value of multiple imagery sessions. Explicit attitudes toward vegetarian nutrition improved over time, but no significant interaction with the intervention was found, potentially due to ceiling effects. Conversely, explicit attitudes toward meat-based nutrition decreased significantly in the intervention group, demonstrating imagery's potential to influence reflective evaluations through negative framing. The results emphasize the effectiveness of an easy and quick-to-use single-session guided imagery intervention for shaping attitudes relevant to sustainable nutrition, particularly by weakening explicit attitudes toward meat consumption and stabilizing positive implicit attitudes toward vegetarian nutrition.

CRediT authorship contribution statement

Fabian Daiss: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Petra Jansen:** Writing – review & editing, Project administration, Methodology, Conceptualization.

Ethical statement

All participants gave informed consent for participation in the study.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT in order to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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The authors 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

Data and material are stored at OSF: osf.io/gahx8.

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