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Peer review process documentation

of the article

An Experimental Approach to Assess The Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices

by

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Review Round 1

Comments by Reviewer A

Summary

The literature distinguishes three different types of environmental knowledge: system knowledge, action-related knowledge, and effectiveness knowledge. The pre-registered study aims to identify the effects of these knowledge types on dietary decisions. Participants read texts including either (a) system knowledge, (b) system and action-related knowledge or (c) system, action-related, and effectiveness knowledge. Two conditions (environment-unrelated knowledge and a high amount of system knowledge) were used as control conditions. The study examined intentions to consume animal products and actual behavior, as participants were able to choose vouchers for different sandwiches and either vegan or milk chocolate.

Results indicate no significant differences in actual behavior, but a reduced intention to consume animal products among participants in the "high system knowledge" and "system, action-related, and effectiveness knowledge" groups. Among other limitations, the study acknowledges that social norms were not taken into account, but has strengths due to the measurement of real behavior.

Overall impression:

My overall impression of the paper was positive. Many of the authors' decisions were clearly explained and presented in a transparent manner, which contributed to the paper's credibility. However, I found it somewhat difficult at times to follow the structure, and the overall line of argumentation lacked coherence in certain parts. In particular, I would have appreciated a more in-depth discussion of potential ways to optimize the study — whether in terms of underlying assumptions, methodology, or overall study design — that might help reveal such effects in future research. Additionally, I would suggest that the discussion include more explanations for the lack of evidence found. In addition to testing the predefined hypotheses, an exploratory analysis could be helpful in gaining deeper insights into underlying mechanisms or contextual factors. This might reveal whether effects occurred within specific subgroups or under certain conditions. Additionally, a stronger connection to the aspects outlined in the introduction (e. g. if environmental knowledge types are multi-faceted or one-dimensional) would have helped round out the discussion and improve internal consistency.

Lastly, I believe the paper would benefit from referencing more recent literature to better reflect the current state of research.

Introduction / Background

- Has the presented research been adequately embedded into a review of previous research?
    - Yes; Clear conceptualization of key constructs and good overview of different research strands.
    - Including more recent literature could further strengthen the theoretical foundation
        - The recently published literature could be used to deepen and expand the theoretic argumentation and to show whether the findings from a few years ago are still up to date
    - Do the authors refer to the literature most relevant to the research question at hand?
        - I would suggest the inclusion of some more (recent and more detailed) literature on the importance of environmental problems caused by the consumption of animal products and the decision to investigate food choices.
-

    -
        - When presenting the research gap, it would have been beneficial to provide more up-to-date literature in order to better reflect the current relevance and need for research in this area.
    - Upfield Europe BV à Consider a more scientific source supporting the claim that an omnivorous diet is more harmful to the environment than a vegan diet (e.g. Springmann et al., 2018). Also, the link provided in the reference list did not work.
- Are research questions well motivated/hypotheses adequately justified? Is the reasoning coherent?
    - For the most part yes. Overall, the paper provides a clear and logical introduction to the hypotheses.
    - But e.g. lines 135-137 mention that knowledge itself is not sufficient to bring about behaviour change, which leads to the question of why this is being researched
    - I understand lines 154-157 to mean that system knowledge influences action-related and efficacy knowledge, which could also be relevant to the hypothesis, as it is difficult to distinguish between them if system knowledge influences the other types anyway.
    - Based on lines 167-185: In my opinion, the argumentation would be more coherent if

1. the study would explain in more detail why they followed the assumption of three different knowledge types or,
2. they would argue that one purpose of the study is to examine whether these three distinguishable environmental knowledge types exist.

-
    - I was wondering why hypothesis 1b) only compares SYS+ACT with SYS, but 1c) compares SYS+ACT+EFF with ENV-UNR and SYS?
        - I asked myself why there was no comparison with the control group in 1b) a standardised hypothesis formulation seems intuitively more logical to me here. Alternatively, I would appreciate it if you emphasised again in the paragraph why the comparison with ENV-UNR was omitted in 1b).
- Is the contribution of the present research to the existing literature made explicit?
    - Yes, the paper effectively emphasises the benefits and value it adds to the field by clearly outlining the research gap it aims to fill and explaining what previous studies have not covered.
- Have all scientific terms and concepts been explicitly defined?
    - Generally yes, but a brief description and argumentation of what the affinity to animal products is and why it is included could be helpful, as the construct is not mentioned before the methods chapter.

Methods:

- Is the research design suited to address the research question at hand?
    - Yes.
    - However, a clearer argument in favour of using the corresponding emissions for the consumption of animal products would be helpful.
        - Accordingly, the hypotheses should explicitly state that the focus is on reducing emissions and not on the amount of animal products consumed.

    - In addition, *greenhouse gas emissions* are mentioned in the introduction, but the measurement only includes CO_2 emissions, but not methane, for example
- Were measures taken to avoid errors, e.g. in error-prone data collection steps such as noting the respondent number or writing down the choice in the office of the test manager? In other words, something like cross-checking by another person.
-
    - Why were sandwiches and chocolate chosen?
- Is the procedure described at a level of detail that allows replication by others?
    - Yes, detailed description
    - Lines 420-427: Was this a manipulation check? Exclusion of participants if they had too many wrong answers?
- Is the operationalization of psychological constructs described in a clear way?
    - Yes, but in some cases more sources would be helpful to clarify where certain conceptual approaches (e. g. the operationalization of the reported consumption of animal products) came from and why they were operationalised in the chosen way. For example, for the instrument to measure consumption of animal products.
    - Chapters 2.1 and 2.3 are somewhat repetitive.
- Is the sample and sampling process described at a sufficient level of detail? This includes the description of sample characteristics, design, measurement tools, operationalization, study procedure, and data analysis. The authors should report all data exclusions and how they determined their sample sizes.
- Some further details should be provided: What was the recruitment process? Was there an a priori calculation of the required sample size?
- Consider also mentioning the university where the students of the sample came from in the final version
-
    - What was the dropout rate for self-reported actual dietary behaviour for the last 7 days four weeks after the intervention (footnote 2)?
    - What was the process of data exclusion? How many people were excluded and for what reasons?
    - Exclusion due to allergies, intolerances, religious or other reasons à in general or just in relation to animal products?
    - Why is the sample for the chocolate much smaller than for the sandwich?

Results:

- Is the chosen analysis strategy clearly described and suitable for answering the research question?
    - Yes
    - Table 1: Why was the pre_consumption x affinity term included? I would recommend an explanation in the previous chapters
- Are all tables and figures necessary, informative and comprehensible?
    - Yes
    - Figure 1: different font à should be uniform; CO_2 instead of CO2 à should be revised
- Is the description of the results separate from their interpretation?
    - Yes
- Is the description of the data and the statistical hypothesis tests complete?

    - Yes,
    - Lines 539-545 and for H3 and H4: I would suggest an explicit naming of the test in the section
    - Did the authors take into account for vegetarian participants that they only had the choice between the cheese and the vegan sandwich?
- Are all relevant tests described and do these descriptions contain test statistics, exact p-values and effect sizes?
    - Yes, possibly consider to include effect sizes for Bayesian confirmatory hypothesis test and also for ANOVA?

Discussion:

- Are all conclusions corroborated by the presented material? Do they follow from the results?
    - Yes.
    - More detailed explanation deviating results: of why there were effects (lines 658-662), but further analysis and the real behavior did not show any significant differences (e. g. lines 670-672)
- Are speculations acknowledged as such?
    - Yes.
- Are results integrated into the existing literature?
    - Yes.
        - However, it would have been helpful to address more clearly the issues raised in the introduction
            - Such as providing insights into the causal relationship between environmental knowledge and individual behaviour that can inform the development of effective educational interventions, or to position the research more clearly with regard to the assumptions mentioned in the introduction (e.g. lines 167-171, are environmental knowledge types multi-faceted or one-dimensional?)
        - Line 656: To emphasize the study as a seminal contribution to the field, it would be more appropriate to refer to a more recent source (instead of e.g., Roczen et al, 2014).
- Are the limitations of applicability discussed as well?
    - Partially:
        - Generalisability of the results to other populations à The limitations of the sample should be emphasised more clearly. For example, it would be important to discuss whether the results can be generalised to other countries or other populations.
        - More explanations as to why the interventions did not show the assumed effects
        - Further approaches for optimisation and opportunities for further research should be discussed.

Practical impact:

- Have the implications of the present work for the application of environmental psychology, practitioners, and the general public been made explicit?
    - Yes
    - Since the introduction highlights the relevance of the study for environmental psychology, it would be advisable to more clearly refer back to the introduction and the cited references in the discussion section.

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- Are these implications specific and do they follow from the presented results?
    - Yes
- Are limitations of applicability discussed as well?
    - Consider a more detailed description

Open science:

- Have the authors reported all measures, conditions, data exclusions, and how they determined their sample sizes?
    - See above (no information on a priori sample size calculation and no clear description of data exclusion)
- Do you know whether the authors preregistered their data? If yes, can you access the preregistration? Are there any unmentioned deviations from the preregistration?
    - Yes
- Do the authors make explicit which of their analyses and results are confirmatory and which are exploratory?
    - Yes
- Have the authors shared their data? Can you access and understand the dataset?
    - I could not access them, but the authors in the manuscript that they are published

Minor points:

- Line 22: "High amount of system knowledge" → Use uniform terminology across the paper (e.g., *much system knowledge*, *high system knowledge*, or *high amount of system knowledge*).
    - Also, standardize references to chocolate (e.g., "vegan/milk chocolate" → use either "vegan and milk chocolate" or "milk and vegan chocolate" consistently).
- Line 307: "Ha1" → Should this be "H1a"?
- Line 321: Why is there a dash (-) behind "system and action-related knowledge"?
- Line 576: "Model1" → Add a space: "Model 1"
- Table 5: "Choice with" → Double space, remove one
- Line 613-614: "Table1" → Add a space: "Table 1"
- Line 740: "study's strengths" → Consider a more objective chapter title

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Comments by Reviewer B

Review of "An Experimental Approach to Assess The Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices" (EPO_34_136)

The manuscript "An Experimental Approach to Assess The Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices" presents an experimental investigation of how different types of environmental knowledge (system, action-related and effectiveness knowledge) affect behavioural intentions and actual behavioural choices in the area of dietary behaviour.

The experimental investigation of the role of environmental knowledge in shaping behavior is innovative and it is highly relevant as the relationship between different types of knowledge and behavior is a central topic in

environmental psychology. The respective causal structure hase so far been based on correlational evidence and has not been tested in experimental designs. While the present study cannot provide empirical confirmation of the assumed causal structure of environmental knowledge types and behaviour, it raises important and stimulating questions for future research. The manuscript is written in a clear and comprehensible manner.
Below, I provide more detailed feedback on the aspects Introduction/Background, Methods, Results, Discussion, Practical Impact, and Open Science.
My main points concern the insight gained regarding the interplay of different types of knowledge in their effect on behavior (see comments for Introduction/Background and Discussion).Overall, I support the publication of a revised version, in which these aspects are more explicitly acknowledged and discussed.

Introduction/Background

The authors provide a comprehensive overview of the existing literature and correctly state that the assumed structure between the different types of environmental knowledge and behaviour has never been tested and point out a gap here. However, the authors should note at this point that they cannot fill this gap (as announced in line 120), but rather take a first step in this direction: The assumed effect structure, e.g., system knowledge influencing behaviour only through action and effectiveness knowledge, cannot be tested with the given design.
An additional difficulty is that the restriction to individual behaviours means that the generally assumed impact structure (i.e., knowledge about the problem offers a reason to get involved - this motivates individuals to research different behaviours, effectiveness knowledge ultimately helps them to choose from a variety of behaviours) does not come into play - in the present case, the behaviour is already set and the effectiveness knowledge may only give an extra nudge in the sense that this one behaviour is worthwhile.

Methods

The entire methodological procedure is presented in a transparent and comprehensible manner and is appropriate to target the research questions. The use of a randomized experimental design strengthens the validity of the findings. The authors' decision to use CO_2 emissions for consumed food and for respective future intentions as an objective measure is commendable. Two minor issues regarding the Methods section: (1) I assume that the study was approved by an ethics committee - this could be stated explicitly in the text. (2) The derivation of the hypotheses in 1.2.1. (intention) is the same for the hypotheses in 1.2.2. (behaviour) and therefore does not need to be repeated in order to avoid redundancy.

Results

The results are clearly presented and well structured and all information required to understand the different results was provided. A table providing an overview of the hypotheses and their confirmation/rejection would be helpful for the reader. A further minor issue regarding the results: The text's references to the individual tables were correct and in appropriate places. However, in my version of the text, the tables themselves appeared several times in sections to which they did not refer, which was initially confusing and hindered comprehension.

Discussion

The authors interpret their findings carefully and conclusions are, for the most part, supported by the results. However, the interpretation of the contradictory results "Quantity matters" (only SYS-SYS-SYS and SYS-ACT-EFF have an effect) vs. 'Quantity does not matter' (no difference between SYS and SYS-SYS-SYS) could have been further elaborated. The authors write that specific content could have had an effect. In addition, the reference to one single behaviour (consumption of animal products) may have led to a particular confounding of the types of

knowledge - for example, the information that meat production is responsible for a large proportion of CO2 emissions also implies a possible course of action.
In addition to more detailed attempts to explain these contradictory results, it would also be interesting to draw on and discuss evidence regarding the two conflicting results from other fields.
I see strong value in the present study especially in inspiring further research on the effect of knowledge (types) on behaviour, which is why further suggestions would be interesting in the discussion: What could future research look like in order to address the question of whether the type or amount of knowledge is decisive? How could the structure of effects (i.e. system knowledge leading to the acquisition of action-related and effectiveness knowledge which in turn are supposed to affect behavior) be investigated longitudinally/ experimentally?

Practical impact

The implications, especially for further research on the knowledge-behavior interplay in the field of sustainability are well stated and limitations are also addressed.

Open science

The study is preregistered, and the registration is accessible and well-structured. Deviations are transparently reported. In contrast to the preregistration file, I was not able to access the materials or code without requesting permission. The authors are transparent about contradictory results from different parts of the study which is commendable in the sense of Open Science.

Minor Issues

1. Line 105-109: "At the individual level, strategies such as incentives or informational campaigns are being pursued to encourage behavior change (e.g. Bergquist et al., 2023), including the Education for Sustainable Development (ESD; United Nations Educational, Scientific and Cultural Organization [UNESCO, 2017]). "

- ESD being presented as a sub-strategy of 'incentives or information campaigns' does not do justice to the scope and ambition of ESD - it is rather the other way round.

1. Line 109-113: "ESD aims at empowering learners to act sustainably by increasing their awareness related to anthropogenic climate change and motivating them to change their behavior. One of the key components of ESD is knowledge transmission (UNESCO, 2014, 2017)."

- What is described here corresponds to a special form of implementation of ESD, namely instrumental ESD (see Wals et al., 2008)

1. Line 689: "Several findings found that behavior intentions are not always translated into corresponding actions"

1. Line 781: "... we made an attempt to fill this gap."

- in the paragraph before, this gap is not specified

Conclusion and Recommendation

This manuscript provides a solid and methodologically sound contribution to the literature on environmental knowledge and behavior. While it does not offer definitive conclusions about the interplay of these constructs, it

provides important initial evidence and provides directions for future investigation. I recommend acceptance after minor revisions, as discussed above.

References

Wals, A. E., Geerling-Eijff, F., Hubeek, F., Van der Kroon, S., & Vader, J. (2008). All mixed up? Instrumental and emancipatory learning toward a more sustainable world: Considerations for EE policymakers. *Applied Environmental Education and Communication*, *7*(3), 55-65.

Author Response to the Reviewers Round 1

We thank the editor Andreas Homburg and both reviewers for their valuable and thorough comments on the first version of our manuscript. We have taken all issues into account and hope that the manuscript has improved considerable. Below, we provide our detailed, point-by-point responses (in *italics*) to the questions and suggestions. We remain open to any further suggestions and are happy to make additional adjustments if needed.
Thank you for your time and consideration.

Answers to the Editor comments

- Could it be that you forgot to upload your supplemental material? (e.g., I cannot find items/scales)
    - *We apologize that we forgot to upload the supplemental material we were referring to in the Method section (Appendices A-C). The stimulus material is accessible via our OSF project (*https://osf.io/9bn87/?view_only=61477579925642c0b15dac9ddbb81ba1*). I have checked the view-only link again, and it seems that after the OSF update and the corresponding new structure, the files were difficult to find. For this reason, I have restructured the OSF project. All materials, as well as data and analysis scripts, can now be retrieved via the "Files" tab. In case of publication, we will of course make the project public and include a non-anonymous link in the manuscript.*
- Also indicate effect sizes in the summary
    - *We added the adjusted Cohen's d for both significant effects in the summary as follows:*
        - *"However, compared to environment-unrelated knowledge, the intention was lower for system, action-related and effectiveness knowledge (adj. Cohen's d = 0.52) and high amount of system knowledge only (adj. Cohen's d = 0.59)" (ll. 40-42).*
        - *" Im Vergleich zur umweltunbezogenen Wissensbedingung war die Intention, tierische Produkte zu konsumieren, bei Teilnehmenden in der System-, Hand-lungs- und Wirksamkeitswissensbedingung (adj. Cohen's d = 0.52) sowie in der Bedingung mit einem hohen Maß an Systemwissen (adj. Cohen's d = 0.59) geringer" (ll. 81-85).*
- Bitte den direkten Link zu den data component einzufügen https://osf.io/9bn87/?view_only=61477579925642c0b15dac9ddbb81ba1) – dann kommt man direkt zu den Daten.
    - *See above (please now refer to the Files tab in the OSF Project).*

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- If helpful, please also upload a codebook
    - *A codebook has been uploaded to OSF. In combination with our R Markdown file for data processing and analyses, this provides readers with comprehensive access to the data and analyses.*
- How long did the knowledge test take (including repetitions)? If relevant, please discuss whether a longer test might have influenced the results
    - *Each single knowledge test consisted of 5 questions on the text that had just been read. Consequently, participants in conditions with texts referring to more environmental knowledge content (e.g., SYS+SYS+SYS) completed more test questions on environmental knowledge content than those in conditions with less (e.g., SYS) or none environmental content. These test questions are therefore considered an integral part of the reading intervention rather than an independent variable that could explain our observed effects. To control for potential "quantity effects," we included the SYS+SYS+SYS control condition, which allows a comparison with the SYS+ACT+EFF condition. We please refer to our RMarkdown file to "Processing Time" with a detailed description of the processing time for each text depending on the condition. Also, with reference to R1, we decided to improve the description of the test questions as follows:*
        - *"After reading each text, participants answered five-single choice test questions on content of that text to ensure that they had acquired the corresponding knowledge. Corrective feedback was provided after each response, and incorrectly answered items were re-presented until recalled correctly. Only then were participants able to continue with the study. This procedure was based on the effect of retrieval practice, also known as the test-ing effect, to induce a high level of recall success and long-term retention of knowledge (Pyc & Rawson, 2009, 2012; for the use in learning environmental knowledge content, see Mundt et al., 2024). This approach addressed the crit-ical issue of low or incorrect participant knowledge in previous studies of en-vironmental knowledge types (e.g., Frick et al., 2004; Fremerey & Bogner, 2014)" (ll. 480-490)*
        - *We also added the previous explanation as a footnote (p. 12): "Participants in conditions with texts referring to more environmental knowledge content (e.g., SYS+SYS+SYS) completed more test questions on environmental knowledge content than those in conditions with less (e.g., SYS) or none (i.e., ENV-UNR). These test questions are therefore considered an integral part of the intervention rather than an independent variable that could explain our observed effects. To account for potential effects of processing time in text reading and test answering, we conducted exploratory analyses excluding extreme outliers in processing times. The results were consistent with those reported in the manuscript and did not change the overall interpretation. Full details of these analyses are available at https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)."*
- Line 504: Refer to Figure 1 if necessary
    - *Thank you for your suggestion. Could you clarify which section of the manuscript you are referring to? In line 504 of the first submission, we were describing the procedure, so referencing Figure 1 there does not seem to fit. We are referring to this figure on line 536 of the current version.*

- Structure the discussion more clearly („Open with a clear statement on the support or nonsupport of the hypotheses or the answers to the questions you first raised in the introduction“ (p 9 https://psychology.yale.edu/sites/default/files/bemempirical.pdf)
    - *As recommended, we restructured our discussion section. Now, the summary of results starts as follows:*
        - *“The present experiment investigated the effect of different environmental knowledge types (i.e., system, action-related, and effectiveness knowledge) on participants’ intention to consume animal products (operationalized by CO2 emission scores in kg) and their actual consumption behavior (i.e., sandwich topping choice; chocolate choice). Imparting different types of environmental knowledge did not lead to differences in participants’ consumption inten-tions or product choices. However, participants who acquired more environ-mental knowledge (i.e., all three environmental knowledge types, or a high system knowledge amount) demonstrated stronger pro-environmental inten-tions than those who learned no environmental knowledge content. To our knowledge, this is the first experimental study on the effects of the three envi-ronmental knowledge types (Player et al., 2023).” (ll.644-655).*
- Table A1: Without information on the response formats, the mean values are difficult to interpret
    - *We added in the Note of Table 1 information on the response format (p. 37):*
        - *For pre-consumption and intention: “Pre-consumption and intention were operationalized by CO_2 emissions score (in kg) for their typical consumption of animal products before the intervention, or respectively, their intended consumption of animal products.*
        - *For affinity of animal products: “Theoretical range between 1-5.”*
- You wrote (in the Letter to the Editors) that you did not know where to place the acknowledgments. They appear to have been lost in the formatting process. We will adjust this (it will be placed in the Author Statement)
    - *Thank you for this clarification. We placed the acknowledgements in the author statement on page 1.*
- In the submitted Word document, the page number breaks off at “16” and then starts again at “2.”
    - *We corrected this mistake as well as the formatting of the Impact-Statement.*

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Answers to Reviewer R1

Overall impression:

- In particular, I would have appreciated a more in-depth discussion of potential ways to optimize the study — whether in terms of underlying assumptions, methodology, or overall study design — that might help reveal such effects in future research.
    - *We added a new paragraph on recommendations for future experiments in the discussion section. Please refer to the section "4.2 Recommendations for future experiments" (pp. 24ff.)*
- Additionally, I would suggest that the discussion include more explanations for the lack of evidence found.
    - *We restructured our discussion section, leading to a new paragraph discussing the conflicting results. Please refer to 4.1 Reasons for conflicting results (pp. 22ff.).*

- In addition to testing the predefined hypotheses, an exploratory analysis could be helpful in gaining deeper insights into underlying mechanisms or contextual factors. This might reveal whether effects occurred within specific subgroups or under certain conditions.
    - *We conducted additional exploratory analyses as suggested, although these were not part of our preregistered study design or original research aims. First, we examined the role of processing time, excluding outliers. These analyses did not provide new or meaningful insights regarding our primary research question. Second, and also referring to your question concerning vegetarians and sandwich topping choice (see below), we did all analyses for vegetarians only and for omnivore participants only. For Vegetarians Only we found neither intervention effects on Intention (N = 60), nor on chocolate choice (N = 35). In case of Sandwich Topping Choice (N = 49, vegan vs. cheese), the binomial regression analyses revealed more vegan choices for SYS+ACT and SYS+SYS+SYS compared to ENV-UNR. In contrast, when excluding the vegetarian participants, a similar pattern of results was found compared to the main analyses. Finally, we conducted exploratory analyses for participants with low versus high affinity for animal product values (based on a median split). For participants with low affinity values (N = 173), we found lower intention for SYS+ACT compared to ENV-UNR, but no other significant differences between the conditions. For participants with high affinity values (N = 131), we found similar pattern of results compared to the main analyses with stronger intentions to consume animal products (i.e., higher CO2 emission scores) in ENV-UNR compared to SYS+ACT+EFF, or SYS+SYS+SYS, respectively.*
    - *To maintain clarity and focus in the main manuscript, we have chosen not to report or discuss these exploratory findings in detail. Instead, we provide the following foodnote 7 when reporting results on sandwich topping choice (p.18): "Exploratively, we analysed solely vegetarian participants, as they could choose only between vegan and cheese toppings. This subgroup analysis on sandwich topping choice (n = 49) indicated significant differences between ENV-UNR and SYS+ACT (OR = 0.06), and ENV-UNR and SYS+SYS+SYS (OR = 0.04), but not among the other conditions. No*

*differences were found for intention (n = 60) or chocolate choice (n = 35). Given the small sample sizes, results should be interpreted with caution. For further details and additional exploratory analyses see https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*).”*

- Additionally, a stronger connection to the aspects outlined in the introduction (e. g. if environmental knowledge types are multi-faceted or one-dimensional) would have helped round out the discussion and improve internal consistency.
    - *Thank you for this valuable suggestion. As noted above, we have restructured the entire discussion section, also to improve its alignment with the introduction. We discuss our findings in terms of quantity vs. quality of environmental knowledge (ll.679-739) and give recommendations how to further examine this research question (ll. 765-775). Further, we provide suggestions how to investigate the interconnectedness of the environmental knowledge types (ll. 776-803). With reference to the dimensionality, we position us as follows: “As it remains empirically unclear whether the proposed three types of environmental knowledge types can clearly be distinguished and whether they affect pro-environmental behavior in different ways, further research is necessary. Despite decades of research on this construct (e.g., Kaiser & Frick, 2002; Player et al., 2023), empirical evidence is lacking, especially from experimental studies. This gap is crucial to address, as these knowledge types are widely recommended despite their uncertain relevance (e.g., Arnold, 2020; Somerwill & When, 2022; Smederrevac-Lalic et al., 2020). Our study may serve as a reference point for future experimental work” (ll. 756-764).*
    - *To strengthen internal consistency, we revised the conclusion to read: “Our findings do not provide clear evidence regarding the validity of the three types of environmental knowledge and differential effects on behavioral intention and behavior: The results suggest both, the importance and the lack of influence of knowledge quantity in shaping pro-environmental intentions.” (ll. 849-852)"*
- Lastly, I believe the paper would benefit from referencing more recent literature to better reflect the current state of research
    - *We have incorporated more recent literature throughout the manuscript and hope that this also adequately addresses the literature-related concerns raised below. Details of the newly added sources are provided in our responses to your specific literature-related comments in the following sections.*

Introduction / Background

- Including more recent literature could further strengthen the theoretical foundation. The recently published literature could be used to deepen and expand the theoretic argumentation and to show whether the findings from a few years ago are still up to date
    - *Thank you for this valuable suggestion. We have incorporated more recent literature throughout the manuscript (Baierl et al., 2022; He et al., 2022; Kolenatý et al., 2022; Maurer & Bogner, 2020). Additionally, we included Player et al. (2023) to emphasize that current research still does not provide clear evidence for the three environmental knowledge types: “Player et al. (2023) found evidence for both a one- and multidimensional environmental knowledge construct” (ll. 173ff). We*

believe that these updates strengthen the theoretical foundation and make our argumentation more current.

- I would suggest the inclusion of some more (recent and more detailed) literature on the importance of environmental problems caused by the consumption of animal products and the decision to investigate food choices
    - *Thank you for this observation. We extended and updated our explanation for choosing animal product consumption as targeted behavior as follows: "We focussed on the consumption of animal products as a high-impact behav-ior to mitigate climate change (Lacroix, 2018; Wynes & Nicholas, 2017). Animal-based foods already account for 57% of global food-related greenhouse gas emissions (Xu et al., 2021). If current dietary pattern persist, food consumption alone could add about 1 °C to global warming by 2100, with high-methane foods such as meat, dairy, and rice responsible for over 80% of this increase (Ivanovich et al., 2023). Consequently, reducing or avoiding animal products is among the most effective individual actions to lower greenhouse gas emissions on individual level and constitutes a critical target for interventions (Lacroix, 2018; Scarborough et al., 2023; Springman et al., 2018; Wynes & Nicholas, 2017)" (ll. 198-208).*
- When presenting the research gap, it would have been beneficial to provide more up-to-date literature in order to better reflect the current relevance and need for research in this area.
    - *See above. We added the following literature on environmental knowledge types: Baierl et al., 2022; He et al., 2022; Kolenatý et al., 2022; Maurer & Bogner, 2020; Player et al., 2023.*
- Upfield Europe BV à Consider a more scientific source supporting the claim that an omnivorous diet is more harmful to the environment than a vegan diet (e.g. Springmann et al., 2018). Also, the link provided in the reference list did not work.
    - *We updated the sources in the paragraph mentioned as follows: "An example for system knowledge is that primary greenhouse gas emissions from livestock production originate from for example deforestation, methane from livestock digestion and manure, or excessive fertilizer usage (Ivanovich et al., 2023; Scarborough et al., 2023; Schlatzer, 2011). Action-related knowledge refers to knowing about strategies for emission reduction in the livestock production (Scarborough et al., 2023; Springman et al., 2018). Effectiveness knowledge comprises the knowledge that a vegan diet generates significantly fewer greenhouse gas emissions than a vegetarian diet, which, in turn, emits less than an omnivore diet (Scarborough et al., 2023; Xu et al., 2021)" (ll. 226-234).*
    - *In the methods section, we retained the original sources because they were used to develop the stimulus material. This includes the Upfield Europe BV source, to acknowledge that it was used. Since this resource is no longer accessible online, we have added the goClimate.de source as a similar, current reference. Accordingly, the text now states: "The text also presented the emissions of various food items, emphasizing the higher emissions associated with animal products compared to plant-based alternatives (e.g., Schlatzer, 2011; Upfield Europe BV, n.d.; see also goClimate.de, 2023, for a similar current resource)" (ll. 459-462).*

- e.g. lines 135-137 mention that knowledge itself is not sufficient to bring about behaviour change, which leads to the question of why this is being researched

- *We acknowledge that the original formulation was misleading and did not accurately convey our intended meaning. We revised our argumentation as follows:*
  - *Ll. 139-145: "Several studies have demonstrated a link between environmental knowledge and behavior (e.g., Geiger et al., 2018; Levine & Strube, 2012; Vicente-Molina et al., 2013). Environmental knowledge is an intellectual prerequisite for conscious behavior change, as it fosters an understanding of environmental issues that motivates individuals to protect the environment (Fremerey & Bogner, 2014; Geiger et al., 2019; Kaiser et al., 2008; Roczen et al., 2010)."*
  - *ll. 253-265: "We examined the effects of the environmental knowledge types on individual's behavior intention as key predictor of pro-environmental behavior (Bamberg & Möser, 2007; Hines et al., 1987; Klöckner, 2013). To capture actual consumption behavior, we included participants' choice of a voucher for a sandwich topping of a local diner (i.e., vegan vs. cheese vs. chicken vs. beef topping) and a choice of a chocolate bar (i.e., vegan vs. milk chocolate). Since various factors may hinder behavioral change (Hu et al., 2025; Klöckner, 2013; van Valkengoed et al., 2022), it is crucial to examine whether certain forms of environmental knowledge are more effective than others in overcoming these barriers, and therefore focus on both, intentions and actual behavior. Moreover, considering real-world behavior as dependent variable enhances the applicability and generalizability of the research, allowing for a more accurate understanding of the impact of environmental knowledge on behavior in practical contexts (see Lange et al., 2023)."*

- I understand lines 154-157 to mean that system knowledge influences action-related and efficacy knowledge, which could also be relevant to the hypothesis, as it is difficult to distinguish between them if system knowledge influences the other types anyway.
  - *You are correct. Our study design does not allow testing whether system knowledge influences behavior via action and efficacy knowledge. Instead, we aimed to provide an initial investigation of the differential effects of these knowledge types on behavioral intentions and behavior. Also in response to Reviewer 2, we have added recommendations for future research in the discussion concerning the interconnectedness of environmental knowledge types: "Another focus of future research should be on examining the interconnectedness of the environmental knowledge types. Specifically, our experimental design does not enable us to investigate whether system knowledge influences behavior through action and efficacy knowledge (Braun & Dierkes, 2019; Frick et al., 2004). There is already evidence for effects of effectiveness knowledge alone (Goldwert et al., 2025; Simon & Merten, 2024), although we cannot rule out that these effects may have been supported by participants' pre-existing system and action-related knowledge. It would therefore be valuable to experimentally test how participants' post-intervention knowledge and behavior-related variables differ when they learn only one type of knowledge, or a combination of two, or all three environmental knowledge types. At the level of knowledge retention, if system knowledge facilitates the acquisition of action-related and effectiveness knowledge, then performance on a post-intervention knowledge test should be higher among participants who learned effectiveness knowledge and action-related knowledge together with system knowledge compared to those who did not. At the behavioral level, if system knowledge influences behavior through action-related and*

effectiveness knowledge, then the effects on the behavior-related variables should be strongest for participants who learned all three knowledge types compared to those who acquired only action-related and effectiveness knowledge. In this context, we recommend combining experimental approaches with longitudinal study designs. Such designs enable the systematic tracking of changes in participants' knowledge over time (Watts et al., 2019) and provide insights into long-term effects (Braun & Dierkes, 2019). This allows for a more nuanced analysis of how specific environmental knowledge types develop, and how these developmental trajectories relate to behavioral outcomes, while accounting for potential moderating and mediating variables. It also enables the investigation of knowledge convergence, whether environmental knowledge, as a multi-dimensional construct, consolidates into a one-dimensional construct over time (Kaiser et al., 2008; Liefländer et al., 2014)" (ll.774-801).

- Based on lines 167-185: In my opinion, the argumentation would be more coherent if

1. the study would explain in more detail why they followed the assumption of three different knowledge types or,
2. they would argue that one purpose of the study is to examine whether these three distinguishable environmental knowledge types exist.
    - *Our focus was on providing a first experimental attempt to investigate if they have different effects on behavioral variables and by this, providing causal evidence for the existence of the three environmental knowledge types. To make this more explicit, we added the following sentences in ll. 186-191: "To address the research gaps regarding environmental knowledge, with this study, we are providing a first experimental attempt to investigate if the three environmental knowledge types proposed in the literature have different effects on behavioral variables. In this way, we aim to establish causal evidence for the multifaceted structure of environmental knowledge."*

- I was wondering why hypothesis 1b) only compares SYS+ACT with SYS, but 1c) compares SYS+ACT+EFF with ENV-UNR and SYS? I asked myself *why* there was no comparison with the control group in 1b) a standardised hypothesis formulation seems intuitively more logical to me here. Alternatively, I would appreciate it if you emphasised again in the paragraph why the comparison with ENV-UNR was omitted in 1b).
    - In fact, the comparison of *SYS+ACT* with *ENV-UNR* in H1a was implicitly included by Hypothesis H1a (SYS < ENV-UNR). However, this approach is methodologically not entirely sound and also inconsistent with H1c. Therefore, we have added the explicit comparison of *SYS+ACT* with both *SYS* and *ENV-UNR for H1b as follows: "Therefore, we hypothesized that the intended consumption of animal products (i.e., the CO_2 emission score in kg) is lower in the system and action-related knowledge (SYS+ACT) condition compared to ENV-UNR and SYS (H1b). Similarly, the probability of choosing a vegan product was expected to be higher in SYS+ACT compared to ENV-UNR and SYS (H2b) because the content of action-related knowledge provides concrete and practicable behav-ioral actions, stimulating behavioral change (e.g., Ajzen, 1991; Liobikienė & Poškus, 2019; Neubig et al., 2020)" (ll.286-293).*
- A brief description and argumentation of what the affinity to animal products is and why it is included could be helpful, as the construct is not mentioned before the methods chapter.

- *We added following description and argumentation for this covariate: "Affinity refers to a positive, largely emotion-driven attitude toward animal-based foods, which can directly influence purchasing decisions independently of objective product evaluations (de Boer & Schösler, 2016; Oberecker et al., 2008; see also meat attachment, Graça et al., 2015). Therefore, participants' affinity for animal products may shape their consumption choices regardless of what they learned about the foods' impact" (ll. 244-249).*

Methods:

- a clearer argument in favour of using the corresponding emissions for the consumption of animal products would be helpful. Accordingly, the hypotheses should explicitly state that the focus is on reducing emissions and not on the amount of animal products consumed. In addition, *greenhouse gas emissions* are mentioned in the introduction, but the measurement only includes CO_2 emissions, but not methane, for example
  - *Thank you very much for these comments, highlighting the need to explain our alternative intention measurement in more detail. While our approach of using a CO_2 emission score for animal products differs from traditional intention measures, it provides a consistent metric across participants. For example, stating that one intends to consume less chicken would have very different implications for a person who eats chicken five times per week compared to someone who consumes it once every two weeks. By converting participants' choices into CO_2 emission scores, we can quantify the potential environmental impact of their (intended) consumption in a standardized way. Thus, the emission score serves as a proxy for consumption intention, enabling transparent and consistent comparisons across a range of products. We believe it is of interest to readers of this manuscript to see this alternative way of operationalizing intention, as it highlights a novel method for linking behavioral intentions to environmental impact. Since participants were asked about the number of portions of specific products they intended to consume, rather than about reducing emissions directly, we retained the wording 'intention to consume animal products' in the manuscript, including the hypotheses. However, to make our approach explicit, we now refer to these variables consistently as 'Intention to Consume Animal Products After the Intervention (Operationalized by CO_2 Emission Score in kg)' and 'Pre-Consumption of Animal Products (Operationalized by CO_2 Emission Score in kg),' respectively. We hope that this wording is acceptable; if there are remaining concerns, we are happy to consider adjustments to the terminology.*
  - *Generally, we focused specifically on CO_2 emissions rather than total greenhouse gas emissions for analytical simplicity and to enhance interpretability for readers. As CO_2 is a major component of greenhouse gas emissions, this choice does not undermine our rationale for targeting animal product consumption as a high-impact behavior. In the introduction (1.2 The present study), we added a short first explanation of our intention measure as follows: "For analytical simplicity and to enhance interpretability for readers, the pre-sent study focused on CO_2 emissions resulting from the consumption of ani-mal products. Thus, participants' intention to consume animal products was operationalized as a CO_2 emission score (in kg) for animal products, providing a standardized alternative to traditional intention measures for quantifying the environmental impact of their*

intended consumption. For example, on traditional intention scales, the same strong intention to reduce chicken consumption leads to different emission reductions for frequent chicken consumers than for those who eat it already rarely. In contrast, CO_2 emission scores enhance the reliability and comparability of consumption pattern (see Morren et al., 2021, and Seger et al., 2023, for similar approaches)" (ll. 206-216).

- Were measures taken to avoid errors, e.g. in error-prone data collection steps such as noting the respondent number or writing down the choice in the office of the test manager? In other words, something like cross-checking by another person.
    - *There was no cross-checking by a second person. However, our assessment procedure was highly standardized and thus very robust against errors. Importantly, only one participant entered the office at a time. By stamping the voucher, the main experimenter could unambiguously record the chosen sandwich, and the distinct appearance of the chocolate wrappings made it easy to identify and document the selected item correctly with the subject number handed over on the small note received in the laboratory. While we cannot completely exclude the possibility of errors, we consider the likelihood to be extremely low. If you see the need, we can add a clarification in the Method section.*
- Why were sandwiches and chocolate chosen?
    - *We aimed to select products that would be attractive to participants as incentives and, at the same time, suitable for use as the study's dependent variable, while remaining logistically and economically feasible. To meet these requirements, we needed a product that offered a variety of options (e.g., different types of meat, dairy-based, and vegan). Providing food directly in the office was not feasible due to hygiene concerns and the risk of food waste. In addition, the university's catering service was unable to provide food vouchers for administrative reasons. We were therefore very grateful for the cooperation with the sandwich store, which not only offered a wide range of sandwich options but also agreed to implement our "study sandwich voucher" procedure. As a sweet counterpart to the sandwich, chocolate was chosen, since it could easily be provided in our office and allowed participants to take it home immediately. If you see the need, we can add a clarification in the Method section.*
- Lines 420-427: Was this a manipulation check? Exclusion of participants if they had too many wrong answers?
    - *This procedure served as a "learning assurance." To ensure that participants truly acquired the key environmental knowledge presented in the reading texts, we provided test questions derived from the stimulus material. Participants were presented with these questions until they answered them correctly. If an item was answered incorrectly, it was shown again until the correct answer was recalled. Importantly, there was no exclusion of participants who required more trials to reach the correct answers. Our interest lay in ensuring that participants possessed the knowledge, not in how long it took them to acquire it. In this way, we implemented the well-established strategy of retrieval practice, one of the most robust methods for promoting long-term knowledge retention.*
    - *Taking also the comment of the editor into account, we added more explanation to this learning test in the Intervention section: "After reading each text, participants answered five-single choice test questions on content of that text to ensure that they had acquired the corresponding knowledge. Corrective feedback was provided after each response, and incorrectly answered items were re-*

presented until recalled correctly. Only then were participants able to continue with the study[4]. This procedure was based on the effect of retrieval practice, also known as the testing effect, to induce a high level of recall success and long-term retention of knowledge (Pyc & Rawson, 2009, 2012; for the use in learning environmental knowledge content, see Mundt et al., 2024). This approach addressed the critical issue of low or incorrect participant knowledge in previous studies of environmental knowledge types (e.g., Frick et al., 2004; Fremerey & Bogner, 2014)" (ll.478-488).

- *Footnote 4 (p.12): [4]Participants in conditions with texts referring to more environmental knowledge content (e.g., SYS+SYS+SYS) completed more test questions on environmental knowledge content than those in conditions with less (e.g., SYS) or none (i.e., ENV-UNR). These test questions are therefore considered an integral part of the intervention rather than an independent variable that could explain our observed effects. To account for potential effects of processing time in text reading and test answering, we conducted exploratory analyses excluding extreme outliers in processing times. The results were consistent with those re-ported in the manuscript and did not change the overall interpretation. Full details of these analyses are available at https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)*

- Is the operationalization of psychological constructs described in a clear way? Yes, but in some cases more sources would be helpful to clarify where certain conceptual approaches (e. g. the operationalization of the reported consumption of animal products) came from and why they were operationalised in the chosen way. For example, for the instrument to measure consumption of animal products.
  - *As stated above already the operationalisation of self-reported animal products consumption (pre-consumption and intended consumption) by CO_2 emission scores provides a consistent metric across participants quantifying the potential environmental impact of their consumption in a standardized way. Please refer to lines 208-216 for the explanation of this approach.*
- Chapters 2.1 and 2.3 are somewhat repetitive.
  - *We consolidated the descriptions of our measures (pre-intervention consumption, intended consumption, and affinity for animal products) into Chapter 2.3. We hope that this revised structure addresses the issue and results in a more concise presentation.*

- Some further details should be provided:
  - What was the recruitment process?
    - *We added the following description of the recruitment process in section 2.2: "Participants were recruited via the online study platform of the Institute of Psychology, announcements in lectures and seminars, posters on campus, and personal contact" (ll.353ff.)*
  - Was there an a priori calculation of the required sample size?
    - *We used a convenience sample, as noted in the Open Science Statement of the manuscript, and did not perform an a priori sample size calculation. If journal policy prefers, we are happy to also include this information in the Methods section for full transparency.*

- Consider also mentioning the university where the students of the sample came from in the final version
  - *We added a placeholder in l. 352 in section 2.2, which will be filled in the final version.*

- What was the dropout rate for self-reported actual dietary behaviour for the last 7 days four weeks after the intervention (footnote 2)?
    - *We added the dropout rate in footnote 2 (p.9): "Due to participants' drop out (10.86%), we dropped analyses of this variable."*
- What was the process of data exclusion? How many people were excluded and for what reasons? Exclusion due to allergies, intolerances, religious or other reasons à in general or just in relation to animal products? Why is the sample for the chocolate much smaller than for the sandwich?
    - *You find the following detailed description in the supplemental material Table SC, which we forgot to upload in the first submission. We apologize for this: "Sample sizes differed due to different exclusion criteria (e.g., lactose intolerance) and drop out of participants during data collection process. For analysing the sandwich topping choice, we excluded four participants who witnessed the sandwich topping choice of a previous participant. Further 50 participants were not interested in receiving the sandwich voucher as reward or even did not show up in the main researcher's office to receive their reward. For analysing the chocolate choice, we excluded data from four participants who were not alone during the decision-making process or got a recommendation. Moreover, we excluded 23 participants who saw the chocolate bars' brands before having made their decision, which might have biased their decision. Twenty-six participants with lactose-intolerance were not included either. Further 40 participants were not interested in the chocolate as reward or did not show up in the main officer's office to receive their reward."*

Results:

- Table 1: Why was the pre_consumption x affinity term included? I would recommend an explanation in the previous chapters
    - *Apart from the previous mentioned definition of affinity for animal products as covariate (ll. 244-249), we added the following short argumentation to include the term in the result section (ll. 545fff): "The consumption of animal products before the intervention, the affinity for animal products, and their interaction were included as additional predictors to consider that the effect of pre-intervention consumption depends on affinity."*
- Figure 1: different font à should be uniform; CO_2 instead of CO2 à should be revised
    - *We adapted the figure's font to EPO's template style and subscripted the "2" in CO2. Please refer to Figure 1 for changes.*
- Lines 539-545 and for H3 and H4: I would suggest an explicit naming of the test in the section
    - *Thank you for this suggestion. In lines 539–545 (first submission), we report descriptive analyses rather than inferential tests, which is why no Hypotheses and statistical test were named in this section. We wonder if you might have been referring to a different part of the manuscript where inferential statistics are reported. Could you clarify which section you had in mind so we can address your concern appropriately?*
    - *With regard to H3 and H4, we changed the paragraphs as follows:*

"Accordingly, we expected no difference in the pattern of results between SYS and SYS+SYS+SYS regarding both, behavioral intentions (operationalized by CO2 emission scores in kg; H3) and actual behavior (i.e., choosing the environmental friendly option in sandwich topping choice and chocolate choice; H4). With respect to H3, the multiple linear regression analysis indicated a lower intention to consume animal products for SYS+SYS+SYS compared to ENV-UNR, corroborating H3a. However, this result did not align with the pattern observed for SYS, as SYS and ENV-UNR did not differ significantly (see Table 1). [...] With respect to H4, binomial regression analyses indicated that SYS and SYS+SYS+SYS followed the same pattern of results for sandwich topping and chocolate choice (see Table 3 and Table 4). In line with H4a, SYS+SYS+SYS did not differ significantly from ENV-UNR. In contrast to H4b and H4c, SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively." (ll. 596-640)

  - *Please also refer to Table 1, as proposed by Reviewer 2 with an overview of all hypotheses and empirical evidence.*

- Did the authors take into account for vegetarian participants that they only had the choice between the cheese and the vegan sandwich?
  - In *response to your objection, we conducted an exploratory analysis for sandwich topping choice including only participants who indicated being vegetarian (N = 49, with 6–12 participants per condition; see also above). Interestingly, the pattern of results in this subgroup differed from the main analysis (showing effects for SYS+ACT and SYS+SYS+SYS compared to ENV-UNR). However, given the very small sample sizes per condition, these results should be interpreted with great caution. We therefore decided to briefly report the main findings in a footnote, referring also to our OSF R Markdown file on exploratory analyses: "Exploratively, we analysed solely vegetarian participants, as they could choose only between vegan and cheese toppings. This subgroup analysis on sandwich topping choice (n = 49) indicated significant differences between ENV-UNR and SYS+ACT (OR = 0.06), and ENV-UNR and SYS+SYS+SYS (OR = 0.04), but not among the other conditions. No differences were found for intention (n = 60) or chocolate choice (n = 35). Given the small sample sizes, results should be interpreted with caution. For further details and additional exploratory analyses see https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)" (Footnote 7).*

- Yes, possibly consider to include effect sizes for Bayesian confirmatory hypothesis test and also for ANOVA?
  - *We calculated adjusted Cohen's d effect sizes for the multiple linear regression and added them in Table 3 and in the text: "The adjusted Cohen's d was 0.52 for ENV-UNR vs. SYS+ACT+EFF and 0.59 for ENV-UNR vs. SYS+SYS+SYS" (ll. 554f.). For our binomial regression analyses, we already reported the Odds Ratios. Regarding the Bayesian confirmatory hypothesis tests, we decided not to include additional effect sizes beyond the Bayes Factor. The magnitude of the Bayes Factor can already be interpreted as the strength of the evidence for a specific effect, and these tests refer to comparisons with restricted versions of the models which are already reported in detail. However, if we have misunderstood your comment, we would appreciate a specific recommendation regarding the effect size measure you would report.*

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Discussion:

- More detailed explanation deviating results: of why there were effects (lines 658-662), but further analysis and the real behavior did not show any significant differences (e. g. lines 670-672)
    - *As stated above already, we added a whole new paragraph discussing the conflicting results. Please refer to 4.1 Reasons for conflicting results (ll. 676-752) for the updated discussion of results.*
- However, it would have been helpful to address more clearly the issues raised in the introduction. Such as providing insights into the causal relationship between environmental knowledge and individual behaviour that can inform the development of effective educational interventions, or to position the research more clearly with regard to the assumptions mentioned in the introduction (e.g. lines 167-171, are environmental knowledge types multi-faceted or one-dimensional?)
    - *In the revised discussion, we have made several efforts to more directly address the issues raised in the Introduction. For example, we start the discussion with the statement: „ The present experiment investigated the effect of different environmental knowledge types (i.e., system, action-related, and effectiveness knowledge) on participants' intention to consume animal products (operationalized by CO2 emission scores in kg) and their actual consumption behavior (i.e., sandwich topping choice; chocolate choice). Imparting different types of environmental knowledge did not lead to differences in participants' consumption intentions or product choices. However, participants who acquired more environmental knowledge (i.e., all three environmental knowledge types, or a high system knowledge amount) demonstrated stronger pro-environmental intentions than those who learned no environmental knowledge content. To our knowledge, this is the first experimental study on the effects of the three environmental knowledge types (Player et al., 2023)" (ll. 642-653).*
    - *We also added the following sentence to the Conclusion: "Our findings do not provide clear evidence regarding the validity of the three types of environmental knowledge and differential effects on behavioral intention and behavior: The results suggest both, the importance and the lack of influence of knowledge quantity in shaping pro-environmental intentions. To further study the structure of environmental knowledge and the differential relationships of knowledge types with pro-environmental behavior, further experimental studies are crucial for a comprehensive understanding of its impact" (ll. 847-853).*
    - *Furthermore, by discussing future experimental approaches on the role of quantity versus quality of environmental knowledge effects (ll. 754-773) and the interconnectedness of the knowledge types (ll. 774-801), we acknowledge the remaining open questions.*
- Line 656: To emphasize the study as a seminal contribution to the field, it would be more appropriate to refer to a more recent source (instead of e.g., Roczen et al, 2014).
    - *The sentence has been revised to: "To our knowledge, this is the first experimental study on the effects of the three environmental knowledge types (Player et al., 2023)." In revising the discussion, we also ensured that, as in the introduction, more recent sources are incorporated throughout the argumentation.*
- Generalisability of the results to other populations: The limitations of the sample should be emphasised more clearly. For example, it would be important to discuss whether the results can be generalised to other countries or other populations.

- *We agree that our sample does not allow for generalization to other populations; however, this was not the aim of this initial investigation. To ensure readers are aware of this limitation, we have highlighted the role of the sample in the section "4.2 Recommendations for Future Experiments." Please refer to ll. 829-842 for the following discussion: "Furthermore, in all these considerations, the sample plays an important role, as it influences the development of the intervention with regard to learning material difficulty, learning format, social norms, and the feasibility of the targeted behavior change (Bamberg & Möser, 2007; Goldwert et al., 2025; Hattie & Donoghue, 2016). Although previous research indicates that environmental knowledge is generally poor across all age groups (e.g., Braun & Dierkes, 2019; Geiger et al., 2019; Morren et al., 2021), we see particular potential in focusing on secondary school students. It can be assumed that all environmental knowledge types, or environmental knowledge in general, are still underdeveloped in this group (Braun & Dierkes, 2019; Geiger et al., 2019; Otto & Kaiser, 2014). As a result, potential effects of knowledge interventions may be larger. Furthermore, focusing on a heterogeneous sample, including gender and social-economic background, but also participants from both the Global North and Global South, would allow drawing conclusions on the generalizability of the findings (Henrich et al., 2010)."*

- More explanations as to why the interventions did not show the assumed effects
  - *As stated above, please refer to 4.1 Reasons for conflicting results (pp. 22ff.)*
- Further approaches for optimisation and opportunities for further research should be discussed.
  - *As stated above, please refer to 4.3 Recommendations for future experiments (pp. 24ff.)*

Practical impact:

- Since the introduction highlights the relevance of the study for environmental psychology, it would be advisable to more clearly refer back to the introduction and the cited references in the discussion section.
- Are limitations of applicability discussed as well?: Consider a more detailed description
  - *Thank you for both suggestions. We have revised the discussion accordingly. We now explicitly refer back to the introduction and emphasize the persistent need for further research, also highlighted its relevance for the practical context. Specifically, we begin Section 4.3 (Recommendations for Future Experiments) as follows: "As it remains empirically unclear whether the proposed three types of environmental knowledge types exist and whether they affect pro-environmental behavior in different ways, further research is necessary. Despite decades of research (e.g., Kaiser & Frick, 2002; Player et al., 2023), clear empirical evidence is lacking, especially from experimental studies. This gap is crucial to address, as these knowledge types are widely recommended despite their uncertain relevance (e.g., Arnold, 2020; Somerwill & When, 2022; Smederrevac-Lalic et al., 2020). Our study may serve as a reference point for future experimental work" (ll. 754-762).*

Open science:

- Have the authors reported all measures, conditions, data exclusions, and how they determined their sample sizes? See above (no information on a priori sample size calculation and no clear description of data exclusion)

  - *We have addressed these points in detail in the responses to the corresponding questions above.*
- I could not access them, but the authors in the manuscript that they are published
  - *I have checked the view-only link again, and it seems that after the OSF update and the corresponding new structure, the files were difficult to find. For this reason, I have restructured the OSF project. All materials, as well as data and analysis scripts, can now be retrieved via the "Files" tab. In case of a publication, we will of course make the project public and include the public link in the manuscript.*

Minor points:

- Line 22: "High amount of system knowledge" → Use uniform terminology across the paper (e.g., *much system knowledge*, *high system knowledge*, or *high amount of system knowledge*).
  - *We have standardized the wording in the main text to "high system knowledge," choosing this shorter label to ensure consistency and improve readability. In the abstract and the impact statement, however, we deliberately kept the longer description "high amount of system knowledge only," so that readers can immediately grasp the distinction between conditions without the need for further explanation. We hope this compromise is acceptable; otherwise, we are of course willing to revise the abstract and impact statement accordingly.*
- Also, standardize references to chocolate (e.g., "vegan/milk chocolate" → use either "vegan and milk chocolate" or "milk and vegan chocolate" consistently).
  - *We opt for „vegan and milk chocolate" and standardized all references to chocolate accordingly.*
- Line 307: "Ha1" → Should this be "H1a"?
  - *Yes! We corrected this mistake.*
- Line 321: Why is there a dash (-) behind "system and action-related knowledge"?
  - *That was a mistake! We deleted it!*
- Line 576: "Model1" → Add a space: "Model 1"
  - *Corrected.*
- Table 5: "Choice with" → Double space, remove one
  - *Corrected.*
- Line 613-614: "Table1" → Add a space: "Table 1"
  - *Corrected.*
- *Line 740: "study's strengths" → Consider a more objective chapter title*
  - *Thank you for the suggestion. Following the restructuring of the discussion section, this chapter title is no longer included. The content originally under this heading has been redistributed into other sections.*

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Answers to Reviewer R2

Introduction/Background

- The authors provide a comprehensive overview of the existing literature and correctly state that the assumed structure between the different types of environmental knowledge and behaviour has never been tested and point out a gap here. However, the authors should note at this point that they cannot fill this gap (as announced in line 120), but rather take a first step in this direction: The assumed effect structure, e.g., system knowledge influencing behaviour only through action and effectiveness knowledge, cannot be tested with the given design.
    - *We thank for this helpful suggestion. We have revised the study aim in the Introduction accordingly: "The present study offers a first step to fill this research gap..." (ll. 127f.).*
    - *Additionally, we discuss in the new Discussion section "4.3 Recommendations for future experiments") how future studies could examine the interconnectedness of the environmental knowledge types: "Another focus of research should be on examining the interconnectedness of the environmental knowledge types. Specifically, our experimental design does not enable us to investigate whether system knowledge influences behaviour solely through action and efficacy knowledge, as was suggested by Frick et al. (2004). There is already evidence for effects of effectiveness knowledge alone (Simon & Merten, 2024; Goldwert et al., 2025), although we cannot rule out that these effects may have been supported by participants' pre-existing system and action-related knowledge. It would therefore be valuable to experimentally test how participants' post-intervention knowledge and behavior-related variables differ when they learn only one type of knowledge, or a combination of two, or all three environmental knowledge types. At the level of knowledge retention, if system knowledge facilitates the understanding of action-related and effectiveness knowledge, then performance on a post-intervention knowledge test should be higher among participants who learned effectiveness knowledge and action-related knowledge together with system knowledge compared to those who did not. At the behavioral level, if system knowledge influences behavior through action-related and effectiveness knowledge, then the effects on the behavior-related variables should be strongest for participants who learned all three knowledge types compared to those who acquired only action-related and effectiveness knowledge. In this context, we recommend combining experimental approaches with longitudinal study designs. Such designs provide insights into long-term effects and enable the systematic tracking of changes in participants' knowledge over time (Watts et al., 2019). This allows for a more nuanced analysis of how specific environmental knowledge types develop, and how these developmental trajectories relate to behavioural outcomes, while accounting for potential moderating and mediating variables. It also enables the investigation of knowledge convergence, whether environmental knowledge, as a multi-dimensional construct, consolidates into a one-dimensional construct over time (Kaiser et al., 2008; Liefländer et al., 2014)" (lines 774-801).*
- An additional difficulty is that the restriction to individual behaviours means that the generally assumed impact structure (i.e., knowledge about the problem offers a reason to get involved - this motivates individuals to research different behaviours, effectiveness knowledge ultimately helps them to choose from

a variety of behaviours) does not come into play - in the present case, the behaviour is already set and the effectiveness knowledge may only give an extra nudge in the sense that this one behaviour is worthwhile.

- *We have discussed this restriction, induced by focussing on one behavior only, in 4.3 "Recommendations for future experiments": "Another approach could address general pro-environmental behavior, focusing on both, low- and high-impact actions (e.g., Goldwert et al., 2025; Kolenatý et al., 2022). This would allow the function of effectiveness knowledge (i.e., the ability to consciously select among different behavioral options ac-cording to its mitigation impact; Kaiser & Fuhrer, 2003; Liefländer et al., 2015) to become more apparent than when focusing on a single behav-ior, where participants are already guided towards the intended behaviour, irrespective of whether they have acquired effectiveness knowledge. Depend-ing on the targeted behavior, additional predictors need to be taken into ac-count that shape the complex relationship between knowledge and behavior, such as environmental concern (Kolenatý et al., 2022), attitudes (Baierl et al., 2022; Roczen et al., 2014), or values (Bolderdijk et al., 2013, Maurer & Bogner, 2020). Mediation and moderation models may be particularly useful for ex-amining how, or whether, different forms of environmental knowledge exert effects (Goldwert et al., 2025; Kolenatý et al., 2022; van Valkengoed et al., 2022)" (ll. 814-828).*

Methods

- Two minor issues regarding the Methods section: (1) I assume that the study was approved by an ethics committee - this could be stated explicitly in the text.
  - *Approval from the ethics committee was not obtained, because ethical review and approval was not required for the study in accordance with the local legislation and institutional requirements. We assure that the present study was carried out in accordance with the ethical, legal, and moral recommendations of the local university and corresponding national association of psychology and with written informed consent according to the World Medical Association Declaration of Helsinki.*
- (2) The derivation of the hypotheses in 1.2.1. (intention) is the same for the hypotheses in 1.2.2. (behaviour) and therefore does not need to be repeated in order to avoid redundancy.
  - *We integrated both paragraphs into one. Please see Section 1.2.1 for changes (pp. 7f.).*

Results

- The results are clearly presented and well structured and all information required to understand the different results was provided. A table providing an overview of the hypotheses and their confirmation/rejection would be helpful for the reader.
  - *Please refer to the new Table 1, summarizing all hypotheses and their empirical support (p.14)*
- A further minor issue regarding the results: The text's references to the individual tables were correct and in appropriate places. However, in my version of the text, the tables themselves appeared several times in sections to which they did not refer, which was initially confusing and hindered comprehension.
  - *We apologize for the previous placement of the tables. We have adjusted their positions in the manuscript and hope that the revised order improves clarity and readability.*

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Discussion

- The authors interpret their findings carefully and conclusions are, for the most part, supported by the results. However, the interpretation of the contradictory results "Quantity matters" (only SYS-SYS-SYS and SYS-ACT-EFF have an effect) vs. 'Quantity does not matter' (no difference between SYS and SYS-SYS-SYS) could have been further elaborated.
    - *In our new section 4.1 Reasons for conflicting results, we discuss these findings in more detail. Please refer to ll. 677-732.*
- The authors write that specific content could have had an effect. In addition, the reference to one single behaviour (consumption of animal products) may have led to a particular confounding of the types of knowledge - for example, the information that meat production is responsible for a large proportion of CO2 emissions also implies a possible course of action.
    - *Thank you for this observation. We have added a new paragraph to the Discussion section in which we address the possibility of confounding. In this paragraph, we also incorporate findings from other research fields, as requested in the up-coming comment: "Moreover, focusing exclusively on animal-based food consumption could have resulted in a confounding of knowledge effects. Knowledge about greenhouse gas emissions from animal livestock production (i.e., system knowledge) or the options for reducing these emissions (i.e., action-related knowledge) lead to the mitigation behavior of consuming little to no animal products, regardless of whether this knowledge was acquired in detail through the effectiveness knowledge condition. Therefore, the effectiveness knowledge text could function more as an additional prompt. Research on attitude–behavior consistency further suggests that knowledge must be relevant to the targeted behavior to produce meaningful change (Fabrigar et al., 2006; Sun et al., 2023). Even individuals with relatively low levels of knowledge (i.e., system knowledge only) can show strong attitude–behavior alignment when their knowledge is directly tied to behavioral goals (Fabrigar et al., 2006). This may explain why not only participants in the SYS+ACT+EFF condition, as well as those in the SYS+SYS+SYS condition, showed lower intentions to consume animal products compared to ENV-UNR, despite the SYS+SYS+SYS condition being limited to system knowledge alone. However, both assumptions are challenged by the finding that SYS and SYS+ACT had no effect on intention and behaviors" (ll.703-720).*
- In addition to more detailed attempts to explain these contradictory results, it would also be interesting to draw on and discuss evidence regarding the two conflicting results from other fields.
    - *We included findings from research on attitude–behavior consistency (Fabrigar et al., 2006; Sun et al., 2023) in the previously mentioned paragraph (ll. 710-718).*
- I see strong value in the present study especially in inspiring further research on the effect of knowledge (types) on behaviour, which is why further suggestions would be interesting in the discussion: What could future research look like in order to address the question of whether the type or amount of knowledge is decisive?
    - *Thank you very much for this suggestion. In our new section 4.2 "Recommendations for future experiments" we address this issue as follows: "One focus of research should be on examining whether the*

quantity or quality of environmental knowledge matters. Similar to our study, conditions such as SYS+SYS+SYS and SYS+ACT+EFF should be compared to SYS and SYS+ACT conditions. However, to rule out recency-effects, the order of text presentation should be varied this time, so that environmental knowledge is also presented as the final text sequence, rather than exclusively at the beginning. Other interesting comparison groups could include a high amount of action-related knowledge only and a high amount of effectiveness knowledge only. If it is the quantity of knowledge that drives effects rather than its quality, then all conditions involving large amounts of environmental knowledge should produce measurable effects compared to conditions involving moderate amounts" (ll. 763-773).

- How could the structure of effects (i.e. system knowledge leading to the acquisition of action-related and effectiveness knowledge which in turn are supposed to affect behavior) be investigated longitudinally/ experimentally?
    - *We address this question in 4.3 Recommendations for future experiments as follows: "Another focus of research should be on examining the interconnectedness of the environmental knowledge types. Specifically, our experimental design does not enable us to investigate whether system knowledge influences behaviour solely through action and efficacy knowledge, as was suggested by Frick et al. (2004). There is already evidence for effects of effectiveness knowledge alone (Simon & Merten, 2024; Goldwert et al., 2025), although we cannot rule out that these effects may have been supported by participants' pre-existing system and action-related knowledge. It would therefore be valuable to experimentally test how participants' post-intervention knowledge and behavior-related variables differ when they learn only one type of knowledge, or a combination of two, or all three environmental knowledge types. At the level of knowledge retention, if system knowledge facilitates the understanding of action-related and effectiveness knowledge, then performance on a post-intervention knowledge test should be higher among participants who learned effectiveness knowledge and action-related knowledge together with system knowledge compared to those who did not. At the behavioral level, if system knowledge influences behavior through action-related and effectiveness knowledge, then the effects on the behavior-related variables should be strongest for participants who learned all three knowledge types compared to those who acquired only action-related and effectiveness knowledge. In this context, we recommend combining experimental approaches with longitudinal study designs. Such designs provide insights into long-term effects and enable the systematic tracking of changes in participants' knowledge over time (Watts et al., 2019). This allows for a more nuanced analysis of how specific environmental knowledge types develop, and how these developmental trajectories relate to behavioural outcomes, while accounting for potential moderating and mediating variables. It also enables the investigation of knowledge convergence, whether environmental knowledge, as a multi-dimensional construct, consolidates into a one-dimensional construct over time (Kaiser et al., 2008; Liefländer et al., 2014)" (ll. 774-801).*

Open science

- The study is preregistered, and the registration is accessible and well-structured. Deviations are transparently reported. In contrast to the preregistration file, I was not able to access the materials or code without requesting permission.
    - *I have checked the view-only link again, and it seems that after the OSF update and the corresponding new structure, the files were difficult to find. For this reason, I have restructured the OSF project. All materials, as well as data and analysis scripts, can now be retrieved via the "Files" tab. In case of a publication, we will of course make the project public and include the public link in the manuscript.*

Minor Issues

- Line 105-109: "At the individual level, strategies such as incentives or informational campaigns are being pursued to encourage behavior change (e.g. Bergquist et al., 2023), including the Education for Sustainable Development (ESD; United Nations Educational, Scientific and Cultural Organization [UNESCO, 2017]). " ESD being presented as a sub-strategy of 'incentives or information campaigns' does not do justice to the scope and ambition of ESD - it is rather the other way round.
- Line 109-113: "ESD aims at empowering learners to act sustainably by increasing their awareness related to anthropogenic climate change and motivating them to change their behavior. One of the key components of ESD is knowledge transmission (UNESCO, 2014, 2017)." What is described here corresponds to a special form of implementation of ESD, namely instrumental ESD (see Wals et al., 2008)

    - *Many thanks for both observations and also for pointing us to Wals et al. (2008). We changed our introduction as follows: "Education for Sustainable Development (ESD; United Nations Educa-tional, Scientific and Cultural Organization [UNESCO, 2017]) represents a communicative policy instrument that operates at the individual level and seeks to encourage sustainable development throughout society (Wals et al., 2008). So-called instrumental ESD (see Wals et al., 2008) aims at empowering learners to act sustainably by increasing their awareness related to anthropo-genic climate change and motivating them to change their behavior, with knowledge transmission as one of the key components (UNESCO, 2014, 2017)" (ll. 113-121).*

Line 689: "Several findings found that behavior intentions are not always translated into corresponding actions".

    - *This sentence is no longer included in the current version of the manuscript due to our restructuring.*

Line 781: "... we made an attempt to fill this gap." In the paragraph before, this gap is not specified

    - *Thank you for pointing that out. Actually, there is also some redundant information in the argument structure. We have shortened that section accordingly, so that the sentence in question is no longer there.*

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Review Round 2

Comments by Reviewer A

Response to response letter Revision of "An Experimental Approach to Assess The Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices"

Dear authors,

Thank you for your response to the revision of "An Experimental Approach to Assess The Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices".

In general, I would like to express my appreciation for the care and diligence with which you have addressed the previous feedback. The clear structure and detailed responses have made the review process much easier and more transparent for me personally.

I have added my comments in pink. I hope those comments are clear. However, if any suggestions require further clarification, please do not hesitate to ask.

Kind regards

Reviewer 1

Answers to Reviewer R1 - **Answers from Reviewer R1 in pink**

Overall impression:

□ In particular, I would have appreciated a more in-depth discussion of potential ways to optimize the study — whether in terms of underlying assumptions, methodology, or overall study design — that might help reveal such effects in future research.□

o *We added a new paragraph on recommendations for future experiments in the discussion section. Please refer to the section "4.2 Recommendations for future experiments" (pp. 24ff.)*

□ Additionally, I would suggest that the discussion include more explanations for the lack of evidence found.□

o *We restructured our discussion section, leading to a new paragraph discussing the conflicting results. Please refer to 4.1 Reasons for conflicting results (pp. 22ff.).*

o Thank you for the reconstruction and those sections, now clearer and more comprehensive - Approved

□ In addition to testing the predefined hypotheses, an exploratory analysis could be helpful in gaining deeper insights into underlying mechanisms or contextual factors. This might reveal whether effects occurred within specific subgroups or under certain conditions.□

o *We conducted additional exploratory analyses as suggested, although these were not part of our preregistered study design or original research aims. First, we examined the role of processing time, excluding outliers. These analyses did not provide new or meaningful insights regarding our primary research question. Second, and also referring to your question concerning vegetarians and sandwich topping choice (see below), we did all analyses for vegetarians only and for omnivore participants only. For Vegetarians Only we found neither intervention effects on Intention (N = 60), nor*

on chocolate choice (N = 35). In case of Sandwich Topping Choice (N = 49, vegan vs. cheese), the binomial regression analyses revealed more vegan choices for SYS+ACT and SYS+SYS+SYS compared to ENV-UNR. In contrast, when excluding the vegetarian participants, a similar pattern of results was found compared to the main analyses. Finally, we conducted exploratory analyses for participants with low versus high affinity for animal product values (based on a median split). For participants with low affinity values (N = 173), we found lower intention for SYS+ACT compared to ENVUNR, but no other significant differences between the conditions. For participants with high affinity values (N = 131), we found similar pattern of results compared to the main analyses with stronger intentions to consume animal products (i.e., higher CO2 emission scores) in ENV-UNR compared to SYS+ACT+EFF, or SYS+SYS+SYS, respectively.

o *To maintain clarity and focus in the main manuscript, we have chosen not to report or discuss these exploratory findings in detail. Instead, we provide the following foodnote 7 when reporting results on sandwich topping choice (p.18): "Exploratively, we analysed solely vegetarian participants, as they could choose only between vegan and cheese toppings. This subgroup analysis on sandwich topping choice (n = 49) indicated significant differences between ENV-UNR and SYS+ACT (OR = 0.06), and ENV-UNR and SYS+SYS+SYS (OR = 0.04), but not among the other conditions. No differences were found for intention (n = 60) or chocolate choice (n = 35). Given the small sample sizes, results should be interpreted with caution. For further details and additional exploratory analyses see https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)."*

o Thank you for the conduction of those exploratory analysis and the report of the results - Approved

□ Additionally, a stronger connection to the aspects outlined in the introduction (e. g. if environmental knowledge types are multi-faceted or one-dimensional) would have helped round out the discussion and improve internal consistency.□

o *Thank you for this valuable suggestion. As noted above, we have restructured the entire discussion section, also to improve its alignment with the introduction. We discuss our findings in terms of quantity vs. quality of environmental knowledge (ll.679-739) and give recommendations how to further examine this research question (ll. 765-775). Further, we provide suggestions how to investigate the interconnectedness of the environmental knowledge types (ll. 776-803). With reference to the dimensionality, we position us as follows: "As it remains empirically unclear whether the proposed three types of environmental knowledge types can clearly be distinguished and whether they affect pro-environmental behavior in different ways, further research is necessary. Despite decades of research on this construct (e.g., Kaiser & Frick, 2002; Player et al., 2023), empirical evidence is lacking,*

especially from experimental studies. This gap is crucial to address, as these knowledge types are widely recommended despite their uncertain relevance (e.g., Arnold, 2020; Somerwill & When, 2022; Smederrevac-Lalic et al., 2020). Our study may serve as a reference point for future experimental work" (ll. 756-764).
o *To strengthen internal consistency, we revised the conclusion to read: "Our findings do not provide clear evidence regarding the validity of the three types of environmental knowledge and differential effects on behavioral intention and behavior: The results suggest both, the importance and the lack of influence of knowledge quantity in shaping pro-environmental intentions." (ll. 849-852)"*
- Approved

□ Lastly, I believe the paper would benefit from referencing more recent literature to better reflect the current state of research□
o *We have incorporated more recent literature throughout the manuscript and hope that this also adequately addresses the literature-related concerns raised below. Details of the newly added sources are provided in our responses to your specific literature-related comments in the following sections.*
- Approved

Introduction / Background
□ Including more recent literature could further strengthen the theoretical foundation. The recently published literature could be used to deepen and expand the theoretic argumentation and to show whether the findings from a few years ago are still up to date□
o *Thank you for this valuable suggestion. We have incorporated more recent literature throughout the manuscript (Baierl et al., 2022; He et al., 2022; Kolenatý et al., 2022; Maurer & Bogner, 2020). Additionally, we included Player et al. (2023) to emphasize that current research still does not provide clear evidence for the three environmental knowledge types: "Player et al. (2023) found evidence for both a one- and multidimensional environmental knowledge construct" (ll. 173ff). We believe that these updates strengthen the theoretical foundation and make our argumentation more current.*
Yes, in my opinion those sources strengthen the theoretical foundation - Approved

□ I would suggest the inclusion of some more (recent and more detailed) literature on the importance of environmental problems caused by the consumption of animal products and the decision to investigate food choices□
o *Thank you for this observation. We extended and updated our explanation for choosing animal product consumption as targeted behavior as follows: "We focussed on the consumption of animal products as a high-impact behavior to mitigate climate change (Lacroix, 2018; Wynes & Nicholas, 2017). Animalbased*

foods already account for 57% of global food-related greenhouse gas emissions (Xu et al., 2021). If current dietary pattern persist, food consumption alone could add about 1 °C to global warming by 2100, with high-methane foods such as meat, dairy, and rice responsible for over 80% of this increase (Ivanovich et al., 2023). Consequently, reducing or avoiding animal products is among the most effective individual actions to lower greenhouse gas emissions on individual level and constitutes a critical target for interventions (Lacroix, 2018; Scarborough et al., 2023; Springman et al., 2018; Wynes & Nicholas, 2017)" (ll. 198-208).
Consider to rewrite *"individual actions on individual levels"* as it might sound repetitive. Additionally, you might omit the reference to rice in *"meat, dairy, and rice responsible for over 80% of this increase (Ivanovich et al., 2023)"* and instead focus on the impact just of animal-based foods. Including rice—a plant-based product—could be confusing, as it does not directly support your argument and may raise questions about whether such foods are also within your research scope. - Partially approved

□ When presenting the research gap, it would have been beneficial to provide more up-to-date literature in order to better reflect the current relevance and need for research in this area.□
o *See above. We added the following literature on environmental knowledge types: Baierl et al., 2022; He et al., 2022; Kolenatý et al., 2022; Maurer & Bogner, 2020; Player et al., 2023.*
- Approved

□ Upfield Europe BV - Consider a more scientific source supporting the claim that an omnivorous diet is more harmful to the environment than a vegan diet (e.g. Springmann et al., 2018). Also, the link provided in the reference list did not work.□
o *We updated the sources in the paragraph mentioned as follows: "An example for system knowledge is that primary greenhouse gas emissions from livestock production originate from for example deforestation, methane from livestock digestion and manure, or excessive fertilizer usage (Ivanovich et al., 2023; Scarborough et al., 2023; Schlatzer, 2011). Action-related knowledge refers to knowing about strategies for emission reduction in the livestock production (Scarborough et al., 2023; Springman et al., 2018). Effectiveness knowledge comprises the knowledge that a vegan diet generates significantly fewer greenhouse gas emissions than a vegetarian diet, which, in turn, emits less than an omnivore diet (Scarborough et al., 2023; Xu et al., 2021)" (ll. 226-234).*
As you explicitly highlight *"that primary greenhouse gas emissions from livestock production originate from for example deforestation, methane from livestock digestion and manure, or excessive fertilizer usage (Ivanovich et al., 2023; Scarborough et al., 2023; Schlatzer, 2011)"* as an example for system knowledge,

I would suggest to clarify that the corresponding descriptions for the other knowledge types are also examples (if that is indeed the case) - Approved

o *In the methods section, we retained the original sources because they were used to develop the stimulus material. This includes the Upfield Europe BV source, to acknowledge that it was used. Since this resource is no longer accessible online, we have added the goClimate.de source as a similar, current reference. Accordingly, the text now states: "The text also presented the emissions of various food items, emphasizing the higher emissions associated with animal products compared to plant-based alternatives (e.g., Schlatzer, 2011; Upfield Europe BV, n.d.; see also goClimate.de, 2023, for a similar current resource)" (ll. 459-462).*
- Approved

□ e.g. lines 135-137 mention that knowledge itself is not sufficient to bring about behaviour change, which leads to the question of why this is being researched□
o *We acknowledge that the original formulation was misleading and did not accurately convey our intended meaning. We revised our argumentation as follows:*
□ *Ll. 139-145: "Several studies have demonstrated a link between environmental knowledge and behavior (e.g., Geiger et al., 2018; Levine & Strube, 2012; Vicente-Molina et al., 2013). Environmental knowledge is an intellectual prerequisite for conscious behavior change, as it fosters an understanding of environmental issues that motivates individuals to protect the environment (Fremerey & Bogner, 2014; Geiger et al., 2019; Kaiser et al., 2008; Roczen et al., 2010)."*
o ▪ *ll. 253-265: "We examined the effects of the environmental knowledge types on individual's behavior intention as key predictor of pro-environmental behavior (Bamberg & Möser, 2007; Hines et al., 1987; Klöckner, 2013). To capture actual consumption behavior, we included participants' choice of a voucher for a sandwich topping of a local diner (i.e., vegan vs. cheese vs. chicken vs. beef topping) and a choice of a chocolate bar (i.e., vegan vs. milk chocolate). Since various factors may hinder behavioral change (Hu et al., 2025; Klöckner, 2013; van Valkengoed et al., 2022), it is crucial to examine whether certain forms of environmental knowledge are more effective than others in overcoming these barriers, and therefore focus on both, intentions and actual behavior. Moreover, considering real-world behavior as dependent variable enhances the applicability and generalizability of the research, allowing for a more accurate understanding of the impact of environmental knowledge on behavior in practical contexts (see Lange et al., 2023)."*
Consider to use a more specific headline for "Expected Effects of Environmental Knowledge" e.g. by referring to: different types of environmental knowledge
o When you mention the barriers ("whether certain forms of environmental

knowledge are more effective than others in overcoming these barriers,"), I I recommend clarifying
□ Examples, what those barriers are,
□ how they are connected with your research topic (i.e. environmental knowledge)
□ and which of those barriers you are able to address with your research
o Maybe you could highlight more clearly why you focus on intention and actual behaviour since your explanation, in which you refer to the barriers, is not entirely clear to me. (i.e. you mean that actual behaviour and intentions have differing barriers?)
o For consistency, consider using one formulation throughout the manuscript (either actual or real world or actual behaviour in real world settings) - Not Approved

□ I understand lines 154-157 to mean that system knowledge influences action-related and efficacy knowledge, which could also be relevant to the hypothesis, as it is difficult to distinguish between them if system knowledge influences the other types anyway.□
o *You are correct. Our study design does not allow testing whether system knowledge influences behavior via action and efficacy knowledge. Instead, we aimed to provide an initial investigation of the differential effects of these knowledge types on behavioral intentions and behavior. Also in response to Reviewer 2, we have added recommendations for future research in the discussion concerning the interconnectedness of environmental knowledge types: "Another focus of future research should be on examining the interconnectedness of the environmental knowledge types. Specifically, our experimental design does not enable us to investigate whether system knowledge influences behavior through action and efficacy knowledge (Braun & Dierkes, 2019; Frick et al., 2004). There is already evidence for effects of effectiveness knowledge alone (Goldwert et al., 2025; Simon & Merten, 2024), although we cannot rule out that these effects may have been supported by participants' pre-existing system and action-related knowledge. It would therefore be valuable to experimentally test how participants' post-intervention knowledge and behavior-related variables differ when they learn only one type of knowledge, or a combination of two, or all three environmental knowledge types. At the level of knowledge retention, if system knowledge facilitates the acquisition of action-related and effectiveness knowledge, then performance on a post-intervention knowledge test should be higher among participants who learned effectiveness knowledge and actionrelated knowledge together with system knowledge compared to those who did not. At the behavioral level, if system knowledge influences behavior through action-related and effectiveness knowledge, then the effects on the behavior-related variables should be strongest for participants who learned all three knowledge types compared to those who acquired only action-related and effectiveness knowledge. In this context, we*

recommend combining experimental approaches with longitudinal study designs. Such designs enable the systematic tracking of changes in participants' knowledge over time (Watts et al., 2019) and provide insights into long-term effects (Braun & Dierkes, 2019). This allows for a more nuanced analysis of how specific environmental knowledge types develop, and how these developmental trajectories relate to behavioral outcomes, while accounting for potential moderating and mediating variables. It also enables the investigation of knowledge convergence, whether environmental knowledge, as a multi-dimensional construct, consolidates into a onedimensional construct over time (Kaiser et al., 2008; Liefländer et al., 2014)" (ll.774-801)

Thank you for the clarification. You mentioned "At the behavioral level, if system knowledge influences behavior through action-related and effectiveness knowledge", which sounds like a mediation assumption to me, which could be referred to later and listed in the discussion as possible future research questions. - Partially approved

□ Based on lines 167-185: In my opinion, the argumentation would be more coherent if□
1. the study would explain in more detail why they followed the assumption of three different knowledge types or,
2. they would argue that one purpose of the study is to examine whether these three distinguishable environmental knowledge types exist.

o *Our focus was on providing a first experimental attempt to investigate if they have different effects on behavioral variables and by this, providing causal evidence for the existence of the three environmental knowledge types. To make this more explicit, we added the following sentences in ll. 186-191: "To address the research gaps regarding environmental knowledge, with this study, we are providing a first experimental attempt to investigate if the three environmental knowledge types proposed in the literature have different effects on behavioral variables. In this way, we aim to establish causal evidence for the multifaceted structure of environmental knowledge."*

- Approved

□ I was wondering why hypothesis 1b) only compares SYS+ACT with SYS, but 1c) compares SYS+ACT+EFF with ENV-UNR and SYS? I asked myself *why* there was no comparison with the control group in 1b) a standardised hypothesis formulation seems intuitively more logical to me here. Alternatively, I would appreciate it if you emphasised again in the paragraph why the comparison with ENV-UNR was omitted in 1b).□

o *In fact, the comparison of SYS+ACT with ENV-UNR in H1a was implicitly included by Hypothesis H1a (SYS < ENV-UNR). However, this approach is methodologically not entirely sound and also inconsistent with H1c. Therefore, we have added the explicit comparison of SYS+ACT with both SYS and ENV-UNR for H1b as follows: "Therefore,*

we hypothesized that the intended consumption of animal products (i.e., the CO_2 emission score in kg) is lower in the system and action-related knowledge (SYS+ACT) condition compared to ENV-UNR and SYS (H1b). Similarly, the probability of choosing a vegan product was expected to be higher in SYS+ACT compared to ENV-UNR and SYS (H2b) because the content of action-related knowledge provides concrete and practicable behav-ioral actions, stimulating behavioral change (e.g., Ajzen, 1991; Liobikienė & Poškus, 2019; Neubig et al., 2020)" (ll.286-293).
- Approved

□ A brief description and argumentation of what the affinity to animal products is and why it is included could be helpful, as the construct is not mentioned before the methods chapter.□
o *We added following description and argumentation for this covariate: "Affinity refers to a positive, largely emotion-driven attitude toward animal-based foods, which can directly influence purchasing decisions independently of objective product evaluations (de Boer & Schösler, 2016; Oberecker et al., 2008; see also meat attachment, Graça et al., 2015). Therefore, participants' affinity for animal products may shape their consumption choices regardless of what they learned about the foods' impact" (ll. 244-249).* □
Maybe the term "affinity for animal products" would be more specific - Approved

Methods:
□ a clearer argument in favour of using the corresponding emissions for the consumption of animal products would be helpful. Accordingly, the hypotheses should explicitly state that the focus is on reducing emissions and not on the amount of animal products consumed. In addition, *greenhouse gas emissions* are mentioned in the introduction, but the measurement only includes CO^2 emissions, but not methane, for example□
□ *Thank you very much for these comments, highlighting the need to explain our alternative intention measurement in more detail. While our approach of using a CO_2 emission score for animal products differs from traditional intention measures, it provides a consistent metric across participants. For example, stating that one intends to consume less chicken would have very different implications for a person who eats chicken five times per week compared to someone who consumes it once every two weeks. By converting participants' choices into CO_2 emission scores, we can quantify the potential environmental impact of their (intended) consumption in a standardized way. Thus, the emission score serves as a proxy for consumption intention, enabling transparent and consistent comparisons across a range of products. We believe it is of interest to readers of this manuscript to see this alternative way of operationalizing intention, as it highlights a novel method for linking behavioral intentions to environmental impact. Since participants were asked about the number of portions of specific products they intended to consume, rather*

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than about reducing emissions directly, we retained the wording 'intention to consume animal products' in the manuscript, including the hypotheses. However, to make our approach explicit, we now refer to these variables consistently as 'Intention to Consume Animal Products After the Intervention (Operationalized by CO_2 Emission Score in kg)' and 'Pre-Consumption of Animal Products (Operationalized by CO_2 Emission Score in kg),' respectively. We hope that this wording is acceptable; if there are remaining concerns, we are happy to consider adjustments to the terminology.
□ *Generally, we focused specifically on CO_2 emissions rather than total greenhouse gas emissions for analytical simplicity and to enhance interpretability for readers. As CO_2 is a major component of greenhouse gas emissions, this choice does not undermine our rationale for targeting animal product consumption as a high-impact behavior. In the introduction (1.2 The present study), we added a short first explanation of our intention measure as follows: "For analytical simplicity and to enhance interpretability for readers, the pre-sent study focused on CO_2 emissions resulting from the consumption of ani-mal products. Thus, participants' intention to consume animal products was operationalized as a CO_2 emission score (in kg) for animal*
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products, providing a standardized alternative to traditional intention measures for quantifying the environmental impact of their intended consumption. For example, on traditional intention scales, the same strong intention to reduce chicken consumption leads to different emission reductions for frequent chicken consumers than for those who eat it already rarely. In contrast, CO_2 emission scores enhance the reliability and comparability of consumption pattern (see Morren et al., 2021, and Seger et al., 2023, for similar approaches)" (ll. 206-216).
- Approved

□ Were measures taken to avoid errors, e.g. in error-prone data collection steps such as noting the respondent number or writing down the choice in the office of the test manager? In other words, something like cross-checking by another person.□
o *There was no cross-checking by a second person. However, our assessment procedure was highly standardized and thus very robust against errors. Importantly, only one participant entered the office at a time. By stamping the voucher, the main experimenter could unambiguously record the chosen sandwich, and the distinct appearance of the chocolate wrappings made it easy to identify and document the selected item correctly with the subject number handed over on the small note received in the laboratory. While we cannot completely exclude the possibility of errors, we consider the likelihood to be extremely low. If you see the need, we can add a clarification in the Method section.*
- Approved

□ Why were sandwiches and chocolate chosen?□

o *We aimed to select products that would be attractive to participants as incentives and, at the same time, suitable for use as the study's dependent variable, while remaining logistically and economically feasible. To meet these requirements, we needed a product that offered a variety of options (e.g., different types of meat, dairy-based, and vegan). Providing food directly in the office was not feasible due to hygiene concerns and the risk of food waste. In addition, the university's catering service was unable to provide food vouchers for administrative reasons. We were therefore very grateful for the cooperation with the sandwich store, which not only offered a wide range of sandwich options but also agreed to implement our "study sandwich voucher" procedure. As a sweet counterpart to the sandwich, chocolate was chosen, since it could easily be provided in our office and allowed participants to take it home immediately. If you see the need, we can add a clarification in the Method section.*

Thank you for your clarification, in fact, I think it would make you decisions more transparent and therefore the paper would benefit from a short explanation in the method section - Partially approved

□ Lines 420-427: Was this a manipulation check? Exclusion of participants if they had too many wrong answers?

o *This procedure served as a "learning assurance." To ensure that participants truly acquired the key environmental knowledge presented in the reading texts, we provided test questions derived from the stimulus material. Participants were presented with these questions until they answered them correctly. If an item was answered incorrectly, it was shown again until the correct answer was recalled. Importantly, there was no exclusion of participants who required more trials to reach the correct answers. Our interest lay in ensuring that participants possessed the knowledge, not in how long it took them to acquire it. In this way, we implemented the well-established strategy of retrieval practice, one of the most robust methods for promoting long-term knowledge retention.*

o *Taking also the comment of the editor into account, we added more explanation to this learning test in the Intervention section: "After reading each text, participants answered five-single choice test questions on content of that text to ensure that they had acquired the corresponding knowledge. Corrective feedback was provided after each response, and incorrectly answered items were re-presented until recalled correctly. Only then were participants able to continue with the study4. This procedure was based on the effect of retrieval practice, also known as the testing effect, to induce a high level of recall success and long-term retention of knowledge (Pyc & Rawson, 2009, 2012; for the use in learning environmental knowledge content, see Mundt et al., 2024). This approach addressed the critical issue of low or incorrect participant knowledge in previous studies of environmental knowledge types (e.g., Frick et al., 2004; Fremerey & Bogner, 2014)" (ll.478-488).*

o *Footnote 4 (p.12): 4Participants in conditions with texts referring to more environmental knowledge content (e.g., SYS+SYS+SYS) completed more test questions on environmental knowledge content than those in conditions with less (e.g., SYS) or none (i.e., ENV-UNR). These test questions are therefore considered an integral part of the intervention rather than an independent variable that could explain our observed effects. To account for potential effects of processing time in text reading and test answering, we conducted exploratory analyses excluding extreme outliers in processing times. The results were consistent with those re-ported in the manuscript and did not change the overall interpretation. Full details of these analyses are available at https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)*
Thank you for your clarification, maybe you could add information about how many trails it took the participants on average to answer the questions right into the paper - Partially approved

□ Is the operationalization of psychological constructs described in a clear way? Yes, but in some cases more sources would be helpful to clarify where certain conceptual approaches (e. g. the operationalization of the reported consumption of animal products) came from and why they were operationalised in the chosen way. For example, for the instrument to measure consumption of animal products.□
o *As stated above already the operationalisation of self-reported animal products consumption (pre-consumption and intended consumption) by CO2 emission scores provides a consistent metric across participants quantifying the potential environmental impact of their consumption in a standardized way. Please refer to lines 208-216 for the explanation of this approach.*
- Approved

□ Chapters 2.1 and 2.3 are somewhat repetitive.□
o *We consolidated the descriptions of our measures (pre-intervention consumption, intended consumption, and affinity for animal products) into Chapter 2.3. We hope that this revised structure addresses the issue and results in a more concise presentation.*
- Approved

□ Some further details should be provided:□
o What was the recruitment process?
□ *We added the following description of the recruitment process in section 2.2: "Participants were recruited via the online study platform of the Institute of Psychology, announcements in lectures and seminars, posters on campus, and personal contact" (ll.353ff.)*
o Was there an a priori calculation of the required sample size?

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□ *We used a convenience sample, as noted in the Open Science Statement of the manuscript, and did not perform an a priori sample size calculation. If journal policy prefers, we are happy to also include this information in the Methods section for full transparency.*
- Approved

□ Consider also mentioning the university where the students of the sample came from in the final version
o *We added a placeholder in l. 352 in section 2.2, which will be filled in the final version.*
- Approved

□ What was the dropout rate for self-reported actual dietary behaviour for the last 7 days four weeks after the intervention (footnote 2)?□
o *We added the dropout rate in footnote 2 (p.9): "Due to participants' drop out (10.86%), we dropped analyses of this variable."*
- Approved

□ What was the process of data exclusion? How many people were excluded and for what reasons? Exclusion due to allergies, intolerances, religious or other reasons à in general or just in relation to animal products? Why is the sample for the chocolate much smaller than for the sandwich?□
□ *You find the following detailed description in the supplemental material Table SC, which we forgot to upload in the first submission. We apologize for this: "Sample sizes differed due to different exclusion criteria (e.g., lactose intolerance) and drop out of participants during data collection process. For analysing the sandwich topping choice, we excluded four participants who witnessed the sandwich topping choice of a previous participant. Further 50 participants were not interested in receiving the sandwich voucher as reward or even did not show up in the main researcher's office to receive their reward. For analysing the chocolate choice, we excluded data from four participants who were not alone during the decision-making process or got a recommendation. Moreover, we excluded 23 participants who saw the chocolate bars' brands before having made their decision, which might have biased their decision. Twenty-six participants with lactose-intolerance were not included either. Further 40 participants were not interested in the chocolate as reward or did not show up in the main officer's office to receive their reward."*
Approved

Results:
□ Table 1: Why was the pre_consumption x affinity term included? I would recommend an explanation in the previous chapters□

□ *Apart from the previous mentioned definition of affinity for animal products as covariate (ll. 244-249), we added the following short argumentation to include the term in the result section (ll. 545fff): "The consumption of animal products before the intervention, the affinity for animal products, and their interaction were included as additional predictors to consider that the effect of pre-intervention consumption depends on affinity."*
Consider to include a reference for the dependence - Approved

□ Figure 1: different font à should be uniform; CO2 instead of CO2 à should be revised□
□ *We adapted the figure's font to EPO's template style and subscripted the "2" in CO2. Please refer to Figure 1 for changes.*
- Approved

□ Lines 539-545 and for H3 and H4: I would suggest an explicit naming of the test in the section□
o *Thank you for this suggestion. In lines 539–545 (first submission), we report descriptive analyses rather than inferential tests, which is why no Hypotheses and statistical test were named in this section. We wonder if you might have been referring to a different part of the manuscript where inferential statistics are reported. Could you clarify which section you had in mind so we can address your concern appropriately?*
Sorry for the misunderstanding, as you mentioned p- values and spoke about group differences, I assumed you did a inferential statistical analyses ("*Participants did not differ in their consumption of animal products before the intervention, F(4, 299) = 0.79, p = .531.*"). In that case, I you had suggested to write something like "As an ANOVA revealed". - Clarification needed

o *With regard to H3 and H4, we changed the paragraphs as follows:*
"Accordingly, we expected no difference in the pattern of results between SYS and SYS+SYS+SYS regarding both, behavioral intentions (operationalized by CO2 emission scores in kg; H3) and actual behavior (i.e., choosing the environmental friendly option in sandwich topping choice and chocolate choice; H4). With respect to H3, the multiple linear regression analysis indicated a lower intention to consume animal products for SYS+SYS+SYS compared to ENV-UNR, corroborating H3a. However, this result did not align with the pattern observed for SYS, as SYS and ENV-UNR did not differ significantly (see Table 1). [...] With respect to H4, binomial regression analyses indicated that SYS and SYS+SYS+SYS followed the same pattern of results for sandwich topping and chocolate choice (see Table 3 and Table 4). In line with H4a, SYS+SYS+SYS did not differ significantly from ENV-UNR. In contrast to H4b and H4c, SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively." (ll. 596-640)
o *Please also refer to Table 1, as proposed by Reviewer 2 with an overview of all hypotheses and empirical evidence.*

- Approved

□ Did the authors take into account for vegetarian participants that they only had the choice between the cheese and the vegan sandwich?□

o *In response to your objection, we conducted an exploratory analysis for sandwich topping choice including only participants who indicated being vegetarian (N = 49, with 6–12 participants per condition; see also above). Interestingly, the pattern of results in this subgroup differed from the main analysis (showing effects for SYS+ACT and SYS+SYS+SYS compared to ENV-UNR). However, given the very small sample sizes per condition, these results should be interpreted with great caution. We therefore decided to briefly report the main findings in a footnote, referring also to our OSF R Markdown file on exploratory analyses: "Exploratively, we analysed solely vegetarian participants, as they could choose only between vegan and cheese toppings. This subgroup analysis on sandwich topping choice (n = 49) indicated significant differences between ENV-UNR and SYS+ACT (OR = 0.06), and ENV-UNR and SYS+SYS+SYS (OR = 0.04), but not among the other conditions. No differences were found for intention (n = 60) or chocolate choice (n = 35). Given the small sample sizes, results should be interpreted with caution. For further details and additional exploratory analyses see https://osf.io/gn3tz/?view_only=61477579925642c0b15dac9ddbb81ba1 (*View-only link for peer-review*)" (Footnote 7).*

- Approved

□ Yes, possibly consider to include effect sizes for Bayesian confirmatory hypothesis test and also for ANOVA?□

o *We calculated adjusted Cohen's d effect sizes for the multiple linear regression and added them in Table 3 and in the text: "The adjusted Cohen's d was 0.52 for ENVUNR vs. SYS+ACT+EFF and 0.59 for ENV-UNR vs. SYS+SYS+SYS" (ll. 554f.). For our binomial regression analyses, we already reported the Odds Ratios. Regarding the Bayesian confirmatory hypothesis tests, we decided not to include additional effect sizes beyond the Bayes Factor. The magnitude of the Bayes Factor can already be interpreted as the strength of the evidence for a specific effect, and these tests refer to comparisons with restricted versions of the models which are already reported in detail. However, if we have misunderstood your comment, we would appreciate a specific recommendation regarding the effect size measure you would report.*

- Approved

Discussion:

□ More detailed explanation deviating results: of why there were effects (lines 658-662), but further analysis and the real behavior did not show any significant differences (e. g. lines 670-672)

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o *As stated above already, we added a whole new paragraph discussing the conflicting results. Please refer to 4.1 Reasons for conflicting results (ll. 676-752) for the updated discussion of results.*

- Approved

□ However, it would have been helpful to address more clearly the issues raised in the introduction. Such as providing insights into the causal relationship between environmental knowledge and individual behaviour that can inform the development of effective educational interventions, or to position the research more clearly with regard to the assumptions mentioned in the introduction (e.g. lines 167-171, are environmental knowledge types multi-faceted or one-dimensional?)□

o *In the revised discussion, we have made several efforts to more directly address the issues raised in the Introduction. For example, we start the discussion with the statement: „ The present experiment investigated the effect of different environmental knowledge types (i.e., system, action-related, and effectiveness knowledge) on participants' intention to consume animal products (operationalized by CO2 emission scores in kg) and their actual consumption behavior (i.e., sandwich topping choice; chocolate choice). Imparting different types of environmental knowledge did not lead to differences in participants' consumption intentions or product choices. However, participants who acquired more environmental knowledge (i.e., all three environmental knowledge types, or a high system knowledge amount) demonstrated stronger pro-environmental intentions than those who learned no environmental knowledge content. To our knowledge, this is the first experimental study on the effects of the three environmental knowledge types (Player et al., 2023)" (ll. 642-653).*

o *We also added the following sentence to the Conclusion: "Our findings do not provide clear evidence regarding the validity of the three types of environmental knowledge and differential effects on behavioral intention and behavior: The results suggest both, the importance and the lack of influence of knowledge quantity in shaping proenvironmental intentions. To further study the structure of environmental knowledge and the differential relationships of knowledge types with pro-environmental behavior, further experimental studies are crucial for a comprehensive understanding of its impact" (ll. 847-853).*

o *Furthermore, by discussing future experimental approaches on the role of quantity versus quality of environmental knowledge effects (ll. 754-773) and the interconnectedness of the knowledge types (ll. 774-801), we acknowledge the remaining open questions.*

- Approved

□ Line 656: To emphasize the study as a seminal contribution to the field, it would be more appropriate to refer to a more recent source (instead of e.g., Roczen et al, 2014).□

□ *The sentence has been revised to: "To our knowledge, this is the first experimental study on the effects of the three environmental knowledge types (Player et al., 2023)." In revising the discussion, we also ensured that, as in the introduction, more recent sources are incorporated throughout the argumentation.*□
- Approved

□ Generalisability of the results to other populations: The limitations of the sample should be emphasised more clearly. For example, it would be important to discuss whether the results can be generalised to other countries or other populations.□
o *We agree that our sample does not allow for generalization to other populations; however, this was not the aim of this initial investigation. To ensure readers are aware of this limitation, we have highlighted the role of the sample in the section "4.2 Recommendations for Future Experiments." Please refer to ll. 829-842 for the following discussion: "Furthermore, in all these considerations, the sample plays an important role, as it influences the development of the intervention with regard to learning material difficulty, learning format, social norms, and the feasibility of the targeted behavior change (Bamberg & Möser, 2007; Goldwert et al., 2025; Hattie & Donoghue, 2016). Although previous research indicates that environmental knowledge is generally poor across all age groups (e.g., Braun & Dierkes, 2019; Geiger et al., 2019; Morren et al., 2021), we see particular potential in focusing on secondary school students. It can be assumed that all environmental knowledge types, or environmental knowledge in general, are still underdeveloped in this group (Braun & Dierkes, 2019; Geiger et al., 2019; Otto & Kaiser, 2014). As a result, potential effects of knowledge interventions may be larger. Furthermore, focusing on a heterogeneous sample, including gender and social-economic background, but also participants from both the Global North and Global South, would allow drawing conclusions on the generalizability of the findings (Henrich et al., 2010)."*
- Approved

□ More explanations as to why the interventions did not show the assumed effects□
o *As stated above, please refer to 4.1 Reasons for conflicting results (pp. 22ff.)*
- Approved

□ Further approaches for optimisation and opportunities for further research should be discussed.□
o *As stated above, please refer to 4.3 Recommendations for future experiments (pp. 24ff.)*
- Approved

Practical impact:
□ Since the introduction highlights the relevance of the study for environmental psychology, it

would be advisable to more clearly refer back to the introduction and the cited references in the discussion section.□
□ Are limitations of applicability discussed as well?: Consider a more detailed description□
o *Thank you for both suggestions. We have revised the discussion accordingly. We now explicitly refer back to the introduction and emphasize the persistent need for further research, also highlighted its relevance for the practical context.*
o *Specifically, we begin Section 4.3 (Recommendations for Future Experiments) as follows: "As it remains empirically unclear whether the proposed three types of environmental knowledge types exist and whether they affect pro-environmental behavior in different ways, further research is necessary. Despite decades of research (e.g., Kaiser & Frick, 2002; Player et al., 2023), clear empirical evidence is lacking, especially from experimental studies. This gap is crucial to address, as these knowledge types are widely recommended despite their uncertain relevance (e.g., Arnold, 2020; Somerwill & When, 2022; Smederrevac-Lalic et al., 2020). Our study may serve as a reference point for future experimental work" (ll. 754-762).*
Editorial: Section 4.3 - maybe you mean 4.2? - Approved

Open science:
□ Have the authors reported all measures, conditions, data exclusions, and how they determined their sample sizes? See above (no information on a priori sample size calculation and no clear description of data exclusion)□
o *We have addressed these points in detail in the responses to the corresponding questions above.*
- Approved

□ I could not access them, but the authors in the manuscript that they are published□
o *I have checked the view-only link again, and it seems that after the OSF update and the corresponding new structure, the files were difficult to find. For this reason, I have restructured the OSF project. All materials, as well as data and analysis scripts, can now be retrieved via the "Files" tab. In case of a publication, we will of course make*
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the project public and include the public link in the manuscript.
- Approved

Minor points:
□ Line 22: "High amount of system knowledge" → Use uniform terminology across the paper (e.g., *much system knowledge*, *high system knowledge*, or *high amount of system knowledge*).□
o *We have standardized the wording in the main text to "high system knowledge," choosing this shorter label to ensure consistency and improve readability. In the abstract and the impact statement, however, we deliberately kept the longer*

description "high amount of system knowledge only," so that readers can immediately grasp the distinction between conditions without the need for further explanation. We hope this compromise is acceptable; otherwise, we are of course willing to revise the abstract and impact statement accordingly.

□ Also, standardize references to chocolate (e.g., "vegan/milk chocolate" → use either "vegan and milk chocolate" or "milk and vegan chocolate" consistently).□

o *We opt for „vegan and milk chocolate" and standardized all references to chocolate accordingly.*

□ Line 307: "Ha1" → Should this be "H1a"?□

o *Yes! We corrected this mistake.*

□ Line 321: Why is there a dash (-) behind "system and action-related knowledge"?□

o *That was a mistake! We deleted it!*

□ Line 576: "Model1" → Add a space: "Model 1"□

o *Corrected.*

□ Table 5: "Choice with" → Double space, remove one□

o *Corrected.*

□ Line 613-614: "Table1" → Add a space: "Table 1"□

o *Corrected.*

□ *Line 740: "study's strengths" → Consider a more objective chapter title*□

o *Thank you for the suggestion. Following the restructuring of the discussion section, this chapter title is no longer included. The content originally under this heading has been redistributed into other sections.*

Everything - Approved

Comments by Reviewer B

Review of the Revised Manuscript "An Experimental Approach to Assess the Impact of Three Environmental Knowledge Types on Food-Related Behavioral Intentions and Choices"

This review relates to the reworked version of the manuscript entitled 'An Experimental Approach to Assess the Impact of Three Types of Environmental Knowledge on Food-Related Behavioural Intentions and Choices'. The study examines how different types of environmental knowledge (system, action-related and effectiveness) impact individuals' intentions and choices regarding food consumption.

In my initial review, I recommended publication of the paper following revisions. The reworked manuscript demonstrates that the authors have carefully and thoroughly addressed these issues. The contradictory results are now discussed in detail, recommendations for future research are provided, and the new presentation of the hypotheses makes the text easier to follow.

Before final acceptance, I would like to raise some remaining issues:

1. **Definition and conceptualization of Education for Sustainable Development (ESD)**

The definition of ESD as a *"communicative policy instrument"* appears too narrow for this broad educational approach (cf. UNESCO, 2017).
In the ESD literature (e.g., Wals et al., 2008), two major orientations are typically distinguished: an instrumental approach, emphasizing behavioral change and the promotion of specific sustainable actions, and an emancipatory approach, emphasizing critical reflection, autonomy, and self-determined engagement with sustainability issues. The authors write *"So-called instrumental ESD (see Wals et al., 2008) aims at empowering learners to act sustainably by increasing their awareness related to anthropogenic climate change and motivating them to change their behavior..."* - The goal of *"empowering learners"* to act sustainably applies to both approaches, with the emancipatory approach perhaps even more closely linked to the notion of empowerment. The emphasis on raising awareness and motivating behavioral change, in turn, actually characterizes the instrumental perspective. The distinction should be correctly referred to or a broader definition of ESD be given without making the explicit distinction between the two approaches necessary in this text.

1. **Table with hypotheses**

While I appreciate the authors' efforts to present the hypotheses systematically and clearly in the new table, I still found it challenging to put the hypotheses together from the different sections of the table and to switch back and forth between intention and behavior.
Furthermore, this presentation method poses the problem that what follows "Hx:..." is not a summary of the respective hypothesis, but can only be understood in combination with the text on the left side of the table. This can lead to confusion. For example, SYS+ SYS+ SYS < ENV-UNR does not describe hypothesis H3a; the complete hypothesis could rather be represented as [SYS+ SYS+ SYS < ENV-UNR] = [SYS < ENV-UNR].
It might be therefore be helpful for the authors to consider formulating the individual hypotheses as complete sentences and formatting the table as follows:

Effects of different knowledge types
Quantity vs. type of knowledge
Intention
H1a
H1b
H1c
H3a
H3b
H3c
Behavior
H2a
H2b
H2c
H4a
H4b
H4c

Finally, shouldn't it be SYS+ SYS+ SYS = ENV-UNR in H4a?

1. **Derivation of the hypothesis regarding system knowledge**

This is an aspect that I had not addressed before, but that caught my attention when going through the revisions: The authors derive the hypothesis that receiving only system knowledge will lead to a change in intention but not in behavior compared to the environmentally unrelated condition, based on the assumption that system knowledge alone may result in simplification and denial/resignation. I think a brief clarification of the reasoning behind these hypotheses would be helpful.

1. **Structure/highlighting of the discussion section**

This is just a matter of individual preference, but the sections on reasons for contradictory results and recommendations for future research currently appear as long, continuous passages of text. These parts could be made more comprehensible through stronger internal structuring, for example by highlighting keywords or using advance organisers to emphasise the main themes (e.g. for reasons for contradictory results: Influence of learning material, sample composition, etc.).

1. **Recommendations for further research – experimental examination of the causal structure of knowledge types**

The authors could be more specific in their recommendations for future experimental investigation of the causal structure of the three environmental knowledge types: what should be manipulated experimentally (e.g. system knowledge), what is the dependent variable (e.g. action-related knowledge – instead of referring generally to a *"knowledge test"*)?

1. **Minor issue – expression (a):**

Line 715: "This may explain why not only participants in the SYS+ACT+EFF condition, as well as those in the SYS+SYS+SYS condition, showed lower intentions to consume animal products compared to ENV-UNR...

- "but also" instead of "as well as"?

1. **Minor issue – expression (a):**

Line 620: *"In contrast to H4b and H4c, SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively."*

- This reads as if the authors were still talking about H4a.
- Recommendation: "In contrast, H4b and H4c were not corroborated: SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively."

In summary, the authors have substantially improved the manuscript and addressed the core issues raised in the initial review. With the amendments suggested above, I consider the paper ready for publication in Environmental Psychology Open.

Literature

UNESCO. (2017). *Education for Sustainable Development Goals: Learning Objectives.* Paris: UNESCO.
Wals, A. E., Geerling-Eijff, F., Hubeek, F., Van der Kroon, S., & Vader, J. (2008). All mixed up? Instrumental and emancipatory learning toward a more sustainable world: Considerations for EE policymakers. *Applied Environmental Education and Communication, 7*(3), 55-65.

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Author Response to the Reviewers Round 2

Dear Andreas Homburg and Reviewers,
We would like to express our sincere gratitude for your careful evaluation of our manuscript and for your thoughtful and constructive feedback. Your valuable suggestions have contributed substantially to improving the quality and clarity of the manuscript.
In the attached document, we address all remaining open questions and outstanding issues. For the sake of clarity and conciseness, only new or still unresolved points are included; comments that were previously addressed and approved have been omitted. Our responses are written in italic for ease of identification.
We remain open to any further suggestions. Thank you for your time and consideration.

ANSWERS TO THE EDITOR

1) New comments from the editor

1. Your write (line line 207 pp) "Following Kollmuss and Agyeman (2002), system knowledge on its own might be simplified by individuals due to the complexity of environmental problems, leading to an underestimation of the problems. This complexity can evoke feelings of helplessness, triggering cognitive defense mechanisms such as denial, resignation, or blame shifting. We assume that in the system knowledge only (SYS) condition, the intention to consume animal products (i.e., the CO_2 emission score in kg) is lower than in the environment-unrelated knowledge (ENV-UNR) condition (H1a)."

   I don't understand that yet. System knowledge hinders a "good" approach to the problem, but on the other hand, it still promotes the intention to eat less meat. How does that fit together, could you comment on this? Please provide an argument for why SYS should have an effect on intention but not on behavior.

   - *Thank you for this request, which also aligns with a comment from Reviewer 2. We have therefore clarified and strengthened the theoretical derivation of our hypotheses as follows: "Empirical evidence suggests that system knowledge does not directly influence pro-environmental behavior (Frick et al., 2004), but affects attitudinal processes that shape intentions (Kaiser et al., 2008). Due to the complexity of environmental problems, system knowledge on its own might be simplified by individuals, leading to an underestimation of the problems, or, can evoke feelings of helplessness, triggering cognitive defense mechanisms such as denial, resignation, or blame shifting (Kollmuss and Agyeman, 2002). Consequently, individuals often fail to translate pro-*

environmental intentions into actual behavior (Hu et al., 2025). Accordingly, we assume that in the system knowledge only (SYS) condition, the intention to consume animal products (i.e., the CO_2 emission score in kg) is lower than in the environment-unrelated knowledge (ENV_UNR) condition (H1a). At the same time, no transfer effects were expected for the environment-related behavior due to the aforementioned simplification processes assumed. Thus, no difference concerning individuals' actual consumption behavior was expected in the current experiment between ENV_UNR and SYS (H2a)." (ll. 274-288)

2. I would like to add that H2a and H4a predict the absence of an effect. I would recommend calculating Bayes factors for these differences and reporting the evidence for the null hypothesis. A non-significant p-value cannot be used as evidence for these hypotheses.
    - *Thank you for this important observation. In response, we conducted the corresponding Bayesian analyses and calculated Bayes factors to directly evaluate the evidence in favor of the null hypotheses implied by H2a and H4a. The resulting Bayes factors are now reported in the Results as follows:*
        - *Ll. 599-608: "Consistent with H2a, both, sandwich topping choice and chocolate choice were not significantly different between ENV_UNR and SYS. To directly test the assumed equality between ENV_UNR and SYS, we further conducted a Bayesian confirmatory hypothesis test with the BF.lm function of the R package BFpack (Mulder et al., 2021). The analysis was based on the regression coefficients using generalized adjusted fractional Bayes factors. For vegan vs. cheese topping choice, the Bayes factor indicated strong evidence for the equality between ENV_UNR and SYS, $BF_{01} = 13.25$. Evidence for equality in vegan vs. meat topping choice was also strong, $BF_{01} = 12.69$. For chocolate choice, evidence for equality between ENV_UNR and SYS was moderate, $BF_{01} = 7.59$. "*
        - *Ll.642-646: In line with H4a, SYS+SYS+SYS did not differ significantly from ENV_UNR. Bayesian confirmatory hypothesis tests provided moderate evidence for equality between ENV_UNR and SYS+SYS+SYS in vegan versus cheese topping choice, $BF_{01} = 3.46$, and strong evidence for equality in vegan vs. meat topping choice, $BF_{01} = 12.74$. For chocolate choice, evidence for equality between ENV_UNR and SYS+SYS+SYS was moderate, $BF_{01} = 5.77$.*
3. In addition, I would also ask you to report 95% confidence intervals for all effect sizes (beta, d, OR).
    - *We have added the corresponding 95% confidence intervals in all tables and in the text. We have also standardised the formats of the tables and hope that they continue to comply with the journal's guidelines.*
4. Line 648: When summarizing the results, please show the connection to the hypotheses.
    - *We have revised the summary of the results to explicitly highlight their connection to the hypotheses as follows, while keeping the discussion concise to help readers follow the main outcomes. Additionally, we refer to* ***Table 1****, already presented in the Results section, which provides a complete overview of all hypotheses and their corroboration. Please check page 22, ll. 668-700 for changes.*

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Minor issues:

- In the new version you state (line 186, highlighted version) „To address the research gaps regarding environmental knowledge, with this study, we are providing a first experimental attempt to investigate if the three environmental knowledge types proposed in the literature have different effects on behavioral variables."
  à I would propose writing the following: "have different (if any) effects on behavioral," variables."
  - *Thank you for this suggestion. We incorporated "(if any)" (l.188 in the revised version).*
- Line 269 ´"`delete
  - *Deleted.*
- Line 611 one space is missing
  - *We carefully re-checked line 611 in the old version of the manuscript but could not identify a missing space. The only element resembling a missing space is the function name BF.lm (now in line 602), which is written without a space by definition. If you were referring to a different line or element, we would be happy to revise it accordingly.*

2) Comments to „Answers to the Editor comments"

- Could it be that you forgot to upload your supplemental material? (e.g., I cannot find items/scales)
- *We apologize that we forgot to upload the supplemental material we were referring to in the Method section (Appendices A-C). The stimulus material is accessible via our OSF project (https://osf.io/9bn87/?view_only=61477579925642c0b15dac9ddbb81ba1). I have checked the view-only link again, and it seems that after the OSF update and the corresponding new structure, the files were difficult to find. For this reason, I have restructured the OSF project. All materials, as well as data and analysis scripts, can now be retrieved via the "Files" tab. In case of publication, we will of course make the project public and include a non-anonymous link in the manuscript.*
  - It could be a temporary problem, but the link https://osf.io/9bn87/?view_only=61477579925642c0b15dac9ddbb81ba1 only shows me „The requested node is no longer available"
  - The link https://osf.io/9yhvk?view_only=9e8145141d9f4c37bb4c42e29268b803 shows (also by "tables") no files

- Bitte den direkten Link zu den data component einzufügen https://osf.io/9bn87/?view_only=61477579925642c0b15dac9ddbb81ba1) – dann kommt man direkt zu den Daten.
  - *See above (please now refer to the Files tab in the OSF Project).*
  - See above.
- If helpful, please also upload a codebook
  - *A codebook has been uploaded to OSF. In combination with our R Markdown file for data processing and analyses, this provides readers with comprehensive access to the data and analyses.*
  - See above

- *We apologize for the inconvenience. We are not sure why the links were temporarily inaccessible. We have therefore created new view-only links and hope that these now allow access to the preregistration (https://osf.io/9yhvk/overview?view_only=96a42bf27197481aaf7c9d5b879029e9) and the OSF project including the files (https://osf.io/gn3tz/overview?view_only=80eaf3d0eb154fd1aab2331f94486518). As an alternative, we could make the OSF project directly public and provide the public URL.*

ANSWERS TO REVIEWER 1

Answers from Reviewer R1 in pink

Introduction / Background

- Consider to rewrite *"individual actions on individual levels"* as it might sound repetitive. Additionally, you might omit the reference to rice in *"meat, dairy, and rice responsible for over 80% of this increase (Ivanovich et al., 2023)"* and instead focus on the impact just of animal-based foods. Including rice—a plant-based product—could be confusing, as it does not directly support your argument and may raise questions about whether such foods are also within your research scope. □ Partially approved
  - *Thank you very much for these two suggestions. We improved this section as follows: "Animal-based foods already account for 57% of global food-related greenhouse gas emissions (Xu et al., 2021). If current dietary pattern persist, food consumption alone could add about 1 °C to global warming by 2100 (Ivanovich et al., 2023). Consequently, reducing or avoiding animal products is among the most effective actions to lower greenhouse gas emissions on individual level and constitutes a critical target for interventions (Lacroix, 2018; Scarborough et al., 2023; Springman et al., 2018; Wynes & Nicholas, 2017)."* (ll. 197-204)
- As you explicitly highlight *"that primary greenhouse gas emissions from livestock production originate from for example deforestation, methane from livestock digestion and manure, or excessive fertilizer usage (Ivanovich et al., 2023; Scarborough et al., 2023; Schlatzer, 2011)"* as an example for system knowledge, I would suggest to clarify that the corresponding descriptions for the other knowledge types are also examples (if that is indeed the case) □ Approved
  - *We agree that the statements provided for the other knowledge types should also be framed as examples for consistency and clarity. We have revised the section as follows: "The following examples illustrate the operationalization of the knowledge types within the learning texts: system knowledge included facts such as primary greenhouse gas emissions from livestock production originate from for example deforestation, methane from livestock digestion and manure, or excessive fertilizer usage (Ivanovich et al., 2023; Scarborough et al., 2023; Schlatzer, 2011); action-related knowledge focused on strategies for emission reduction in the livestock production (Scarborough et al., 2023; Springman et al., 2018); effectiveness knowledge conveyed that a vegan diet generates significantly fewer greenhouse gas emissions than a vegetarian diet, which, in turn, emits less than an omnivore diet*

(Scarborough et al., 2023; Xu et al., 2021).” (ll. 222-232)

- Consider to use a more specific headline for “Expected Effects of Environmental Knowledge" e.g. by referring to: different types of environmental knowledge
  - *We appreciate this suggestion. We changed the headline to “1.2.1 Expected Effects of the Three Environmental Knowledge Types” (l. 250)*
- When you mention the barriers (“whether certain forms of environmental knowledge are more effective than others in overcoming these barriers,”), I I recommend clarifying
  - Examples, what those barriers are,
  - how they are connected with your research topic (i.e. environmental knowledge)
  - and which of those barriers you are able to address with your research
- Maybe you could highlight more clearly why you focus on intention and actual behaviour since your explanation, in which you refer to the barriers, is not entirely clear to me. (i.e. you mean that actual behaviour and intentions have differing barriers?)
  - *Thank you for these comments. We agree that our previous wording may have suggested a stronger and more explicit focus on “barriers” than intended. We have therefore revised this section and streamlined the argumentation, no longer discussing barriers as a separate construct. We hope that the following revised explanation makes our rationale for focusing on both intentions and behavior clearer: “We examined the effects of the environmental knowledge types on individual’s behavior intention as key predictor of pro-environmental behavior (Bamberg & Möser, 2007; Hines et al., 1987; Klöckner, 2013). To capture actual consumption behavior, we included participants’ choice of a voucher for a sandwich topping of a local diner (i.e., vegan vs. cheese vs. chicken vs. beef topping) and a choice of a chocolate bar (i.e., vegan vs. milk chocolate). Thus, while intentions primarily reflect cognitive and motivational processes, the translation of pro-environmental intentions into behavior is often con-strained by additional factors, including individual factors (e.g., habits), situational constraints (e.g., limited access to sustainable alternatives), and social environmental factors (e.g., social norms; Hu et al., 2025; Klöckner, 2013; van Valkengoed et al., 2022). It is crucial to examine whether certain forms of environmental knowledge are more effective than others in overcoming these fac-tors or constraints, and therefore focus on both, intentions and actual behavior. Moreover, considering actual behavior as dependent variable enhances the applicability and generalizability of the research, allowing for a more accurate understanding of the impact of environmental knowledge on behavior in practical contexts (see Lange et al., 2023).”* (ll. 251-267).
- For consistency, consider using one formulation throughout the manuscript (either actual or real world or actual behaviour in real world settings) □ Not approved
  - *Thank you for this observation. For consistency, we have chosen to use **“actual behavior”** throughout the manuscript and have corrected the relevant instances accordingly.*
- Thank you for the clarification. You mentioned “At the behavioral level, if system knowledge influences behavior through action-related and effectiveness knowledge”, which sounds like a mediation assumption to me, which could be referred to later and listed in the discussion as possible future research questions. □ Partially approved

- *Thank you for this suggestion. We included this aspect after the mentioned paragraph as follows: "In this context, we recommend combining experimental approaches with other designs to gain a more complete understanding. Correlative, mediation-focused analyses can additionally examine the mediation pathways described above. Longitudinal study designs can complement experiments by tracking changes in participants' knowledge over time (Watts et al., 2019) and providing insights into long-term effects (Braun & Dierkes, 2019)." (ll. 831-836)*

- A brief description and argumentation of what the affinity to animal products is and why it is included could be helpful, as the construct is not mentioned before the methods chapter.
  - *We added following description and argumentation for this covariate: "Affinity refers to a positive, largely emotion-driven attitude toward animal-based foods, which can directly influence purchasing decisions independently of objective product evaluations (de Boer & Schösler, 2016; Oberecker et al., 2008; see also meat attachment, Graça et al., 2015). Therefore, participants' affinity for animal products may shape their consumption choices regardless of what they learned about the foods' impact" (ll. 244-249).*
  - Maybe the term "affinity for animal products" would be more specific □ Approved
    - *Thank you for this suggestion. To ensure clarity, we have now consistently used the full term "affinity for animal products" throughout the paragraph. The revised text reads: "Further, we assessed affinity for animal products as a possible covariate, which refers to a positive, largely emotion-driven attitude toward animal-based foods, which can directly influence purchasing decisions independently of objective product evaluations (de Boer & Schösler, 2016; Oberecker et al., 2008; see also meat attachment, Graça et al., 2015). Therefore, participants' affinity for animal products may shape their consumption choices regardless of what they learned about the foods' impact." (ll. 243-249)*

Methods:

- Why were sandwiches and chocolate chosen?
  - *We aimed to select products that would be attractive to participants as incentives and, at the same time, suitable for use as the study's dependent variable, while remaining logistically and economically feasible. To meet these requirements, we needed a product that offered a variety of options (e.g., different types of meat, dairy-based, and vegan). Providing food directly in the office was not feasible due to hygiene concerns and the risk of food waste. In addition, the university's catering service was unable to provide food vouchers for administrative reasons. We were therefore very grateful for the cooperation with the sandwich store, which not only offered a wide range of sandwich options but also agreed to implement our "study sandwich voucher" procedure. As a sweet counterpart to the sandwich, chocolate was chosen, since it could easily be provided in our office and allowed participants to take it home immediately. If you see the need, we can add a clarification in the Method section.*
  - Thank you for your clarification, in fact, I think it would make you decisions more transparent and therefore the paper would benefit from a short explanation in the method section □ Partially approved
    - *We added the following footnote in the design section (refer to Footnote 2, page 9):*

> *"The selection of these products for assessing actual consumption behavior was guided by practical and methodological considerations. We aimed to choose incentives that were attractive to participants, feasible to provide, and suitable as dependent variables. Sandwiches were selected because they offered a variety of options (e.g., different types of meat, dairy-based, and vegan), and the cooperating local sandwich store was able to implement the voucher procedure required for our study. Chocolate was chosen as a sweet counterpart because it could be easily distributed in the office and taken home immediately by participants."*

- Lines 420-427: Was this a manipulation check? Exclusion of participants if they had too many wrong answers?
    - Thank you for your clarification, maybe you could add information about how many trails it took the participants on average to answer the questions right into the paper □ Partially approved
        - *We added the following information in ll. 492f.: "Participants took on average M = 1.22 (SD = 0.67) trials to answer each question."*

Results:

- Table 1: Why was the pre_consumption x affinity term included? I would recommend an explanation in the previous chapters
    - *Apart from the previous mentioned definition of affinity for animal products as covariate (ll. 244-249), we added the following short argumentation to include the term in the result section (ll. 545fff): "The consumption of animal products before the intervention, the affinity for animal products, and their interaction were included as additional predictors to consider that the effect of pre-intervention consumption depends on affinity."*
    - Consider to include a reference for the dependence □ Approved
        - *We added "(Graça et al., 2015)" as reference (ll. 559f.)*
- Lines 539-545 and for H3 and H4: I would suggest an explicit naming of the test in the section
    - *Thank you for this suggestion. In lines 539–545 (first submission), we report descriptive analyses rather than inferential tests, which is why no Hypotheses and statistical test were named in this section. We wonder if you might have been referring to a different part of the manuscript where inferential statistics are reported. Could you clarify which section you had in mind so we can address your concern appropriately?*
    - Sorry for the misunderstanding, as you mentioned p- values and spoke about group differences, I assumed you did a inferential statistical analyses ("*Participants did not differ in their consumption of animal products before the intervention, F(4, 299) = 0.79, p = .531.*"). In that case, I you had suggested to write something like "As an ANOVA revealed". □ Clarification needed
        - *We followed your recommendation an changed the sentence as follows: "Before the intervention, participants in the different conditions did not differ in their consumption of animal products as an ANOVA revealed, F(4, 299) = 0.79, p = .531." (l. 550)*

Discussion:

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- Editorial: Section 4.3 □ maybe you mean 4.2? □ Approved
    - *Yes, we apologize for the typo.*

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ANSWERS TO REVIEWER 2

Review 2

Before final acceptance, I would like to raise some remaining issues:

- **Definition and conceptualization of Education for Sustainable Development (ESD)**

The definition of ESD as a *"communicative policy instrument"* appears too narrow for this broad educational approach (cf. UNESCO, 2017).

In the ESD literature (e.g., Wals et al., 2008), two major orientations are typically distinguished: an instrumental approach, emphasizing behavioral change and the promotion of specific sustainable actions, and an emancipatory approach, emphasizing critical reflection, autonomy, and self-determined engagement with sustainability issues. The authors write *"So-called instrumental ESD (see Wals et al., 2008) aims at empowering learners to act sustainably by increasing their awareness related to anthropogenic climate change and motivating them to change their behavior..."* - The goal of *"empowering learners"* to act sustainably applies to both approaches, with the emancipatory approach perhaps even more closely linked to the notion of empowerment. The emphasis on raising awareness and motivating behavioral change, in turn, actually characterizes the instrumental perspective. The distinction should be correctly referred to or a broader definition of ESD be given without making the explicit distinction between the two approaches necessary in this text.

  - *We highly appreciate your clarification and suggestions regarding the definition of Education for Sustainable Development. Upon reflection, we decided to remove the specific reference to ESD from the introduction. While ESD can serve as one example of educational initiatives, it is not central to the research questions or design of our study. The revised text now focuses on educational initiatives more broadly, highlighting their role in strengthening individuals' action competence and pro-environmental behavior. We believe this broader framing is more appropriate for the context of our study and avoids introducing unnecessary distinctions between different approaches to ESD, which are beyond the scope of the current work. The revised introduction reads as follows: "Climate change poses an imminent threat to both the environment and human health and requires urgent action to curb anthropogenic greenhouse gas emissions at all levels (Intergovernmental Panel on Climate Change, 2023). In response to these challenges, educational initiatives and programs have been developed with the aim of raising learners' awareness and motivation for pro-environmental engagement (UNESCO, 2014, 2017; Varela-Losada et al., 2016, Wals et al., 2008), with knowledge transfer being a central component within these educational approaches (Perrenoud, 2010). Therefore, to design environmental education programs that can effectively support pro-environmental behavior, it is essential to determine which knowledge content is most influential." (ll. 112-121).*

- **Table with hypotheses**

While I appreciate the authors' efforts to present the hypotheses systematically and clearly in the new table, I still found it challenging to put the hypotheses together from the different sections of the table and to switch back and forth between intention and behavior.

Furthermore, this presentation method poses the problem that what follows "Hx:..." is not a summary of the respective hypothesis, but can only be understood in combination with the text on the left side of the table. This can lead to confusion. For example, SYS+ SYS+ SYS < ENV-UNR does not describe hypothesis H3a; the complete hypothesis could rather be represented as [SYS+ SYS+ SYS < ENV-UNR] = [SYS < ENV-UNR].

It might be therefore be helpful for the authors to consider formulating the individual hypotheses as complete sentences and formatting the table as follows:

Effects of different knowledge types
Quantity vs. type of knowledge
Intention
H1a
H1b
H1c
H3a
H3b
H3c
Behavior
H2a
H2b
H2c
H4a
H4b
H4c

Finally, shouldn't it be SYS+ SYS+ SYS = ENV-UNR in H4a?

- *Thank you very much for your constructive feedback on Table 1. We have implemented the suggested revisions in the updated version of Table 1. We also appreciate your careful reading and for pointing out the typo in H4a; this has been corrected. Please check page 14f. for changes.*

- **Derivation of the hypothesis regarding system knowledge**

This is an aspect that I had not addressed before, but that caught my attention when going through the revisions: The authors derive the hypothesis that receiving only system knowledge will lead to a change in intention but not in behavior compared to the environmentally unrelated condition, based on the assumption that system knowledge alone may result in simplification and denial/resignation. I think a brief clarification of the reasoning behind these hypotheses would be helpful.

- *Thank you for this request, which also aligns with a comment from the editor. We have therefore clarified and strengthened the theoretical derivation of our hypotheses as follows*: "*Empirical evidence suggests that system knowledge does not directly influence pro-environmental behavior (Frick et al., 2004), but affects attitudinal processes that shape intentions (Kaiser et al., 2008). Due to the complexity of environmental problems, system knowledge on its own might be simplified by individuals, leading to an underestimation of the problems, or, can evoke feelings of helplessness, triggering cognitive defense mechanisms such as denial, resignation, or blame shifting (Kollmuss and Agyeman, 2002). Consequently, individuals often fail to translate pro-environmental intentions into actual behavior (Hu et al., 2025). Accordingly, we assume that in the system knowledge only (SYS) condition, the intention to consume animal products (i.e., the CO_2 emission score in kg) is lower than in the environment-unrelated knowledge (ENV_UNR) condition (H1a). At the same time, no transfer effects were expected for the environment-related behavior due to the aforementioned simplification processes assumed. Thus, no difference concerning individuals' actual consumption behavior was expected in the current experiment between ENV_UNR and SYS (H2a).*" (ll. 274-288)

- **Structure/highlighting of the discussion section**

This is just a matter of individual preference, but the sections on reasons for contradictory results and recommendations for future research currently appear as long, continuous passages of text. These parts could be made more comprehensible through stronger internal structuring, for example by highlighting keywords or using advance organisers to emphasise the main themes (e.g. for reasons for contradictory results: Influence of learning material, sample composition, etc.).

- *We fully understand and appreciate this comment. To address it, and in line with the journal's formatting guidelines, we have introduced subheadings to provide clearer internal structure. We also made minor adjustments to transitions to improve readability for the audience. Please see Sections 4.1 and 4.2 in the Discussion for these revisions.*

The authors could be more specific in their recommendations for future experimental investigation of the causal structure of the three environmental knowledge types: what should be manipulated experimentally (e.g. system knowledge), what is the dependent variable (e.g. action-related knowledge – instead of referring generally to a *"knowledge test"*)?

- *We appreciate this suggestion to more explicitly outline our proposed research design. We have revised the corresponding paragraph as follows: "At the level of knowledge retention, if system knowledge facilitates the acquisition of action-related and, in turn, effectiveness knowledge, then participants who learned these knowledge types together with system knowledge should perform better on the corresponding post-intervention knowledge tests. Specifically, participants should score higher on an action-related knowledge test when they previously learned both system and action-related knowledge, compared to participants who learned only action-related knowledge. Likewise, if action-related knowledge facilitates the acquisition of effectiveness knowledge, participants should score highest on an effectiveness knowledge test when they learned system,*

action-related, and effectiveness knowledge together, compared to participants who learned only effectiveness knowledge or action-related plus effectiveness knowledge. At the behavioral level, if system knowledge influences behavior indirectly through action-related and, subsequently, effectiveness knowledge, then effects on behavior-related variables should be strongest among participants who learned all three knowledge types, compared to those who acquired only action-related and/or effectiveness knowledge." (ll. 815-830)

- **Minor issue – expression (a):**

Line 715: "This may explain why not only participants in the SYS+ACT+EFF condition, as well as those in the SYS+SYS+SYS condition, showed lower intentions to consume animal products compared to ENV-UNR…

- "but also" instead of "as well as"?
    - *Thank you for this observation. It also made us aware of the overall complexity of the sentence. We revised it for clarity and now state: "This reasoning may help explain why not only the SYS+ACT+EFF condition but also the SYS+SYS+SYS condition showed lower intentions to consume animal products compared to ENV-UNR, even though the latter contained only system knowledge." (ll.742-746).*

1. **Minor issue – expression (a):**

Line 620: *"In contrast to H4b and H4c, SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively."*

- This reads as if the authors were still talking about H4a.
- Recommendation: "In contrast, H4b and H4c were not corroborated: SYS+SYS+SYS did not differ significantly from SYS+ACT and SYS+ACT+EFF, respectively."
    - *We followed your recommendation and changed the sentence as suggested (ll.647f.).*