

Peer review process documentation

of the article

Pictorial Warning Nudges Can Reduce Plastic Packaging Use

by

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Review Round 1

Comments by Reviewer A

Summary & general evaluation:

The Paper „Pictorial Warning Nudges Can 1 Reduce Plastic Consumption” presents the results of 2 experimental online studies in which the effect of pictorial nudges on hypothetical plastic consumption behavior of participants was investigated. In addition to the examination of a general effect of the nudges on participants’ hypothetical plastic consumption, findings on possible mediators for such an effect (environmental attitude and shame) were investigated, as well as the question of whether a behavioral effect of the nudges is caused by their aversive character, or whether an environmental reference of the nudges is relevant. Thanks to the clear and straightforward study design, it is very easy to understand what was done and what results were achieved by the studies.

Unfortunately, the straightforward study design also highlights the overarching problem of the paper/ its underlying studies: Unfortunately, the focus on the problem behavior (i.e., plastic consumption) is far too reduced. This is already very clear in the theoretical background, in which there are hardly any (if not even no) clear theoretical and/or empirical explanations for how the problem behavior arises in the first place or what the important influencing factors are here. Only the behavior itself and nudges research are actually discussed - the latter unfortunately almost exclusively in relation to health research. The research design chosen in both studies is unfortunately so extremely limited that, in my view, no reliable findings can be derived on this basis. Furthermore, there are several methodological issues considering the sample and especially the used measures for independent and dependent variable (especially considering the fact, that there is no information on the quality of the scales/items in the paper anyway; see below for further details).

Against this background, in my view, the studies described in the paper represent more of an initial, empirical basis/preliminary study for the development and implementation of a more comprehensive/ theoretically appropriately founded and methodologically more comprehensively designed study. Even if some of the points of criticism can certainly be resolved by a comprehensive revision of the paper (e.g. more detailed description of the methodological approach, appropriate reflection of the problem and theoretical background, etc., see below for details), such a revision unfortunately could not fundamentally change my overall conclusion on the 2 studies presented in the paper here. Thus, based solely on the 2 studies described here, I am therefore unfortunately unable to recommend publication of the paper (even after a fundamental revision) - as already noted, in my view the study results presented here should only be considered as part (preliminary studies) of a more comprehensive further research program.

Detailed feedback and recommendations:

Introduction/Background:

- Has the presented research been adequately embedded into a review of previous research?
 - As already mentioned above, I see major weaknesses in the current presentation. A lot of reference is made here to research in the area of smoking behavior - however, even with regard to this research, I am not sure whether the pattern of findings on the effect of pictorial nudges is really as uniform here as the presentation in the paper makes it seem: I think that the findings here are rather ambivalent - especially considering possible reactance and habit effects (a corresponding classification would of course also be very relevant for the discussion of the findings of the two studies).
 - What I find fundamentally missing in the paper, however, is the theoretical and empirical discussion of the explanation of the problem behavior addressed in the studies (plastic consumption): here I would

also like to see an explanation for the overall problem background/ why the focus on plastic consumption intervention es even necessary from an pro-environmental perspective (the plastic issue is not automatically a particularly pressing issue from every sustainability perspective, so I think it is important to classify it appropriately and also with regard to German consumers, who are examined in the 2 studies here). But as I said, I particularly miss the psychological explanatory perspective on the problem behavior focused in the paper - only very few constructs and findings are reported here and unfortunately the research design is correspondingly reduced (especially in study 1, but also in study 2) and in part I find the hypotheses in study 2 difficult to understand against this background (e.g. hypothesis 2 on the mediator function of environmental attitude, see below for further explanations). I would also like to see more background on research on the effect of pictorial nudges, label, prompts or similar in the environmental psychological research field; there is certainly a lot of research here (in the food sector there are many discussions about pictorial labels and there are certainly some empirical studies on this); research on the effect of image interventions would also be a good point of reference, which definitely exists in the field of environmental psychology.

- Do the authors refer to the literature most relevant to the research question at hand?
 - Relevant literature is cited, but only for an extremely small/reduced theoretical background. In line with my comments above, this should of course also be significantly expanded.
- Are research questions well motivated/hypotheses adequately justified? Is the reasoning coherent?
 - Unfortunately, appropriately formulated hypotheses can only be found in study 2. But here too, the justifications for the assumptions are sometimes difficult to understand, as already noted, especially with regard to hypothesis 2: As tested by the authors later, the mediation assumption here presupposes that environmental attitude was influenced by the intervention - but why should a nudge have an influence on an attitude? In my view, this makes no sense considering the conception of nudge interventions (they are rather assumed to have a direct behavioral influence, but no cognitive effect). Furthermore, in view of the lack of theoretical background to explain the problem behavior, I find all considerations on the effect of the intervention and thus also the formulated hypotheses as a whole unfortunately difficult to understand.
- Is the contribution of the present research to the existing literature made explicit?
 - That is difficult to say. The authors justify their contribution mainly by saying that there is research on the effect of pictorial nudges primarily in the health sector and not in the environmental sector; however, I do not (completely) share this view - in my view, there is a lot of similar research here (which unfortunately is not adequately reflected in the paper); I think the contribution of the studies could be relevant, but more in the sense of preliminary studies as a basis for a new/further study in which the conceptual weaknesses of the current studies are specifically addressed.
- Have all scientific terms and concepts been explicitly defined?
 - I am very unsure whether the classification of the intervention carried out here as a “nudge” is actually appropriate. Shouldn’t the illustrations used rather be classified as “prompts” because they communicate certain (problem) information? There should at least be an appropriate reflection on this issue (nudge vs. prompt) in the paper. Furthermore, environmental attitude does not appear to me to be uniformly defined in the paper, either conceptually or with regard to the selected operationalizations - in Study 1, for example, a very old scale is used to measure environmental attitude in a rather general way and in Study 2, parts of the scale are replaced by very specific items related to plastic. Thus, there is a lack of an overarching/coherent definition and operationalization here.

Methods:

- Is the research design suited to address the research question at hand?
 - With regard to the study groups (EG-CG design) basically yes, but according to my criticism of the theoretical background, the design is far too reduced with regard to the independent variables captured in the studies. I also find the measurement of the dependent variable in both studies very questionable (using only 1 item to measure the DV per study, for me, seems quite inappropriate in general; and, as also noted by the authors, especially in study 1 using an item examining participants' purchasing behavior with regards to purchasing for another person is extremely inappropriate).
- Is the procedure described at a level of detail that allows replication by others?
 - Unfortunately, no. I know that the authors have noted that they cannot show the original nudges in the paper due to copyright issues, but from my point of view this is a very big problem: Especially with regards to study 2, I unfortunately have no clear idea based on the text description what the plastic-unrelated nudge in particular looked like on the bottle. I would also like to see the exact descriptions for the scenarios (i.e., exactly the texts from the questionnaire; unfortunately, I could not find these in the online material). I am also missing a few details from the actual data acquisition process: How long was the survey? Were there "no answer"-answering options? When/ how were socio-demographic variables captured? Were there any attention check measures? Only in study 2 was the exclusion of 2 respondents due to age described, was there otherwise no data cleansing or a corresponding check? And when/ how were the subjects randomized to the study groups?
- Is the operationalization of psychological constructs described in a clear way?
 - All items are listed in tables, but as I said, there is a strong deviation in the measurement between study 1 and 2 in the scale for measuring environmental attitude, which is highly critical. In addition, there is no information on the quality of the scales formed.
- 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.
 - Although the sample sizes are well justified, as already mentioned above, the sampling process is not described at a sufficient level of detail. In addition to the issues already mentioned above, it would also be important to obtain more information on the socio-demographics of the sample in order to better classify the findings (the paper only provides information on the age and gender of the participants).

Results:

- Is the chosen analysis strategy clearly described and suitable for addressing the research question?
 - In view of the measurement (in particular the 1-item measurement for the DV per study), the analysis seems appropriate. However, logistic regressions etc. naturally only provide comparatively weaker empirical evidence than other analyses would do if it had been possible to form an interval-scaled DV per study. I therefore propose, as already described at the beginning of my review, to conduct a new, more comprehensive study with optimized scales for measuring IVs and DVs, in which the quality of different analysis methods is also taken into account.

- Are all tables and figures necessary, informative, and comprehensible?
 - As already mentioned, pictures of the tested nudges would be extremely important to get a really clear idea of what was really done here.
- Is the description of results separated from their interpretation?
 - Yes.
- Is the description of data and statistical hypothesis tests complete? Are all relevant tests described and do these descriptions include test statistics, exact p-values, and effect sizes?
 - Yes.

Discussion:

- Are all conclusions corroborated by the presented material? Do they follow from the results?
- Are speculations acknowledged as such?
- Are results integrated into the existing literature?
- Are the limitations of the reported study and the generalizability of the results to other populations and situations adequately discussed?
 - I would like to give an overall assessment here: In view of the already comprehensively described weaknesses in the theoretical background of the paper, it is of course hardly surprising that the problems existing there are also reflected in the discussion section. Here, too, the reflection on the findings is rather superficial in my view. There is also a lack of classification of the findings in important previous research on plastic consumption and also on the impact evaluation of comparable intervention approaches in the field of the promotion of pro-environmental consumption behaviors. Unfortunately, references are again only made to the health sector. In view of the many conceptual and methodological weaknesses of the two studies conducted, I also find the reflection on the limitations of the studies in the paper far too rough and superficial.

Practical impact:

- Have the implications of the present work for the application of environmental psychology, practitioners, and the general public been made explicit?
- Are these implications specific and do they follow from the presented results?
- Are limitations of applicability discussed as well?
 - Here, too, I would like to give an overarching assessment: Due to the severe conceptual and methodological weaknesses of the studies conducted, I unfortunately cannot grant the findings and the paper in its entirety any real practical relevance. Particularly with regard to possible practical implications of a new and comprehensively revised study idea on the same topic, as proposed, I recommend above all discussing the practical implications of such a study, especially with regard to possible reactance and habit effects in the effects of pictorial-based prompts/ nudges (as already mentioned above with regard to the theoretical background).

Recommendation: Reject Submission

Comments by Reviewer B

The article reports the results of two online-experiments investigated the effect of simple pictorial warning to reduce plastic consumption. Experiment 1 revealed that a pictorial warning nudge reduced the choice of single-use plastic carrier bags. Experiment 2 confirmed this effect for the choice of plastic bottles. However, experiment 2 also revealed that this effect could be assigned to the general aversiveness of the pictures, and not to their plastic-relatedness. Further, results of Experiment 2 were consistent with a partial causal mediation, indicating that shame partially mediated the nudging effect on the choice of plastic bottles. No such mediation effect was revealed for environmental attitude, which in general affected bottle choice across all nudging conditions.

The article is well-structured and readable. It contains all the necessary information to understand the authors' interpretation. The chosen data analysis methods are appropriate and were applied professionally. The results are presented and discussed adequately. The fact that the intervention was effective in both experiments strengthens confidence in the stability of the results. The authors also discuss the limitations of their experiments, particularly the fact that participants in the online studies had to make decisions in a fictitious situation. The effectiveness of visual warnings would need to be tested in a real sales context. Overall, however, the authors provide a good foundation for such follow-up studies. I recommend publishing the manuscript.

Recommendation: Accept Submission

Comments by Reviewer C

The manuscript presents the results of two online experiments that examined the effect of shocking images on reducing plastic waste in an environmentally friendly way. Based on a one-factor between-subjects design, Experiment 1 shows that a pictorial nudge with aversive content (a seal suffocating in a plastic bag) reduces the purchase of plastic bags when a textile bag is available as a more expensive alternative. In Experiment 2, the effects of two specific aversive nudge contents were tested: an environmental and a non-environmental pictorial warning. Compared to a situation without a nudge, the results indicate that the effect of pictorial warning nudges on reducing plastic waste is due to their aversive content. No additional influence could be detected for the environmental nudge. Furthermore, Experiment 2 showed that the effect of aversive nudges on reducing the consumption of plastic bottles is partly mediated by feelings of shame.

Overall, the study is characterized by a straightforward and clearly structured methodological design. The most important finding of the two experiments is that the use of aversive pictorial nudges reduces waste from plastic bags and plastic bottles when behavioral alternatives are available. The content of the pictorial nudges does not need to be related to the environment. The important factor was an aversive association. A feeling of shame that arises when plastic waste is generated was identified as an explanatory mechanism for the effect of visual nudges. These key findings from the two experiments are presented clearly and comprehensively in the manuscript. The manuscript thus provides relevant insights for environmental psychology and should therefore be published in EPO.

However, two aspects of the manuscript should be clarified to make it more accessible to readers in the field of environmental psychology.

1. A stronger theoretical link to intervention research in environmental psychology should be made. The concept of nudges originally comes from behavioral economics. To my knowledge, no theoretical links to intervention methods in environmental psychology are established there. However, environmental psychology has been investigating forms of intervention for some time that are very similar to nudges but are termed differently. Here, it seems to me that the greatest conceptual overlap exists with the intervention method of prompts/prompting. The authors should therefore consider the relationship between pictorial warning nudges

and prompting in environmental psychology: Which psychological mechanisms are addressed in each case (fear induction, memory activation, information transfer, etc.)? Where are the differences and where are the similarities? The explanations in lines 112 to 127 could be expanded significantly on this point. The review by "Gemmecke et al. (2025) Prompting change: A systematic review and meta-analysis of the (un)biased effects of prompts on environmentally friendly behavior, *Applied Psychology*. 2025;74:e70003" provides a useful and up-to-date source of information.

In this context, please explain the statement "we can examine the scalability of pictorial warnings as a nudge intervention" (lines 133-134).

1. The "General Discussion" section should be structured more clearly. It would be helpful to distinguish between the three topics "Summary of results and theoretical contribution," "Limitations and future studies," and "Practical implications" and to mark them with subheadings. Overall, the structure should address the limits of generalizability and transferability of the results in more detail.

In this regard, the aversive nature of the two nudges in Experiment 2 is not sufficiently reflected. All three aversive nudges used in Experiments 1 and 2 visualize a threat to animals. This activates a normative frame of reference of animal protection or animal welfare. This topic should be addressed in the general discussion and could possibly be included in the introduction. The following issues should be considered: Is there a risk of confusing environmental protection and animal protection/welfare due to the stimulus material used? How do these two normative perspectives relate to each other? How can this be addressed in a more differentiated manner in future studies?

In this context, connections can also be made to health psychology, which, from a normative perspective, is focused on self-protection and is therefore primarily egoistic. The explanations in lines 471 to 478, which already address the differences between health promotion and environmental protection, can also be integrated here.

In addition, the specific form of environmental behavior under investigation, which is only briefly mentioned in lines 504/505, should be explained. For the target behavior of reduced use of plastic bags and bottles, clear and relatively easy-to-implement behavioral alternatives are available, such as cloth bags and plastic bottles. For what other types of environmental behavior can pictorial warnings be expected to have little or no effect?

In addition, an assessment of the effect sizes (Z : 349/350) would be informative for readers interested in the use of aversive pictorial warnings compared to other behavioral interventions.

As a suggestion, the following points should be revised to improve the quality of the manuscript content:

1. The term "plastic consumption" is very broad. Throughout the text (and possibly also in the title), it could be clarified as "reduction of plastic packaging."
2. There is a hypothetical assumption about Experiment 1 (see lines 174, 183), even though the analysis is exploratory in nature. Please explicate this hypothetical assumption as in Experiment 2 on page 8.
3. Due to their central importance to both experiments, the images used on the bags and bottles should be presented. This would allow for a better assessment of their content and graphic quality.
4. In Experiment 2, participants were given information about the deposit, weight, and price per liter for plastic and glass bottles. To what extent is this information intended to support an "informed decision" (line 335)? Are these three values intended to illustrate the environmental relevance of the decisions? Was it verified whether participants accessed this information or took it into account in their decision?

Recommendation: Accept Submission

Decision of Handling Editor: Major Revision

Review Round 2

Response Letter to Review Round 1

Dear Anke Blöbaum, and Reviewers,

We sincerely thank you for the opportunity to revise and resubmit our manuscript. We greatly appreciate your thoughtful and constructive feedback, which has been invaluable in improving our work. We have carefully considered all comments and hope that we have addressed them adequately.

In the following, we provide detailed responses to each of the reviewers' comments. For clarity, we have retained the original comments and inserted our responses directly below them, highlighted in **magenta**. We hope that our revisions meet your expectations and look forward to your further evaluation.

Thank you very much for your time and consideration.

Response to Reviewer A

Summary & general evaluation:

The Paper „Pictorial Warning Nudges Can 1 Reduce Plastic Consumption” presents the results of 2 experimental online studies in which the effect of pictorial nudges on hypothetical plastic consumption behavior of participants was investigated. In addition to the examination of a general effect of the nudges on participants' hypothetical plastic consumption, findings on possible mediators for such an effect (environmental attitude and shame) were investigated, as well as the question of whether a behavioral effect of the nudges is caused by their aversive character, or whether an environmental reference of the nudges is relevant. Thanks to the clear and straightforward study design, it is very easy to understand what was done and what results were achieved by the studies.

Unfortunately, the straightforward study design also highlights the overarching problem of the paper/ its underlying studies: Unfortunately, the focus on the problem behavior (i.e., plastic consumption) is far too reduced. This is already very clear in the theoretical background, in which there are hardly any (if not even no) clear theoretical and/or empirical explanations for how the problem behavior arises in the first place or what the important influencing factors are here. Only the behavior itself and nudges research are actually discussed - the latter unfortunately almost exclusively in relation to health research.

The research design chosen in both studies is unfortunately so extremely limited that, in my view, no reliable findings can be derived on this basis. Furthermore, there are several methodological issues considering the sample and especially the used measures for independent and dependent variable (especially considering the fact, that there is no information on the quality of the scales/items in the paper anyway; see below for further details).

Against this background, in my view, the studies described in the paper represent more of an initial, empirical basis/preliminary study for the development and implementation of a more comprehensive/theoretically appropriately founded and methodologically more comprehensively designed study. Even if some of the points of criticism can certainly be resolved by a comprehensive revision of the paper (e.g. more detailed description of the methodological approach, appropriate reflection of the problem and theoretical background, etc., see below for details), such a revision unfortunately could not fundamentally change my overall conclusion on the 2 studies presented in the paper here. Thus, based solely on the 2 studies described here, I am therefore

unfortunately unable to recommend publication of the paper (even after a fundamental revision) - as already noted, in my view the study results presented here should only be considered as part (preliminary studies) of a more comprehensive further research program.

We would like to sincerely thank Reviewer A for the detailed and thoughtful critique of our manuscript. Although the reviewer raised substantial concerns, the comments provided important guidance that enabled us to improve the manuscript considerably. In response, we fundamentally revised the manuscript, including substantial conceptual, theoretical, and structural changes. In the following, we provide a detailed point-by-point response to the reviewer's comments and outline the corresponding revisions made in the manuscript.

Detailed feedback and recommendations:

Introduction/Background:

- Has the presented research been adequately embedded into a review of previous research?

As already mentioned above, I see major weaknesses in the current presentation. A lot of reference is made here to research in the area of smoking behavior - however, even with regard to this research, I am not sure whether the pattern of findings on the effect of pictorial nudges is really as uniform here as the presentation in the paper makes it seem: I think that the findings here are rather ambivalent - especially considering possible reactance and habit effects (a corresponding classification would of course also be very relevant for the discussion of the findings of the two studies).

We appreciate this critical observation on our argumentation line. Based on these and Reviewer D's comments, we added further literature that goes beyond research on smoking behavior. For example, in Chapter 1.1 (page 4), we now summarize Pictorial Warning Effects in the Environmental Domain.

Possible effects of reactance are now discussed in the general discussion on page 24f., ll. 882-897: "Finally, future research should examine for whom pictorial warnings are most effective. The present studies served as an initial test of pictorial warnings in the context of plastic packaging and therefore included only limited socio-demographic information. More detailed assessments of factors such as education, income, pro-environmental attitudes, and political orientation may help identify subgroups that respond particularly strongly or weakly to such interventions (e.g., Bamberg & Möser, 2007; Klein et al., 2019; Wyss et al., 2022). In this context, future research should consider whether pictorial warnings elicit defensive or reactant responses in subgroups differing in these characteristics. As with many visible and negatively framed interventions, some degree of resistance or reactance is to be expected (e.g., Bergquist & Nilsson, 2016). Evidence from the tobacco domain suggests that pictorial warning labels can elicit defensive responses in some individuals and thereby attenuate intervention effectiveness (e.g., Hall, Sheeran et al., 2018), while nevertheless being perceived by many consumers as legitimate and useful tools for communicating risks (e.g., Hall, Marteau et al., 2018; Sychareun et al., 2015).

Also, possible habit-effects are now considered in the general discussion (page 21, ll. 787-796): "Future studies should therefore investigate whether pictorial warnings on plastic packaging continue to affect consumer behavior in naturalistic purchasing environments. This includes examining potential habituation effects and the question of whether pictorial warnings remain effective over longer periods of repeated exposure or primarily exert effects during the initial implementation phase. The field experiment by Luo et al. (2022), which reported reductions in plastic waste over a six-week intervention period when combining a recycling sign with a pictorial warning, provides promising initial evidence that such effects may persist beyond short-term exposure."

What I find fundamentally missing in the paper, however, is the theoretical and empirical discussion of the explanation of the problem behavior addressed in the studies (plastic consumption): here I would

also like to see an explanation for the overall problem background/ why the focus on plastic consumption intervention is even necessary from an pro-environmental perspective (the plastic issue is not automatically a particularly pressing issue from every sustainability perspective, so I think it is important to classify it appropriately and also with regard to German consumers, who are examined in the 2 studies here). But as I said, I particularly miss the psychological explanatory perspective on the problem behavior focused in the paper - only very few constructs and findings are reported here and unfortunately the research design is correspondingly reduced (especially in study 1, but also in study 2) and in part I find the hypotheses in study 2 difficult to understand against this background (e.g. hypothesis 2 on the mediator function of environmental attitude, see below for further explanations). I would also like to see more background on research on the effect of pictorial nudges, label, prompts or similar in the environmental psychological research field; there is certainly a lot of research here (in the food sector there are many discussions about pictorial labels and there are certainly some empirical studies on this); research on the effect of image interventions would also be a good point of reference, which definitely exists in the field of environmental psychology.

We appreciate this important and constructive suggestion regarding the theoretical embedding of our research. In response, we substantially revised the introduction. Specifically, we now begin by summarizing the existing, although still limited research on pictorial warnings and related interventions in environmental contexts (Chapter 1.1). We further added a new section conceptualizing pictorial warnings within broader behavioral intervention frameworks (Chapter 1.2). In this section, we discuss the potential affective and cognitive mechanisms underlying pictorial warnings, including their possible prime-like and prompt-like functions. In addition, we now provide a more detailed discussion of plastic packaging consumption as the target behavior of the intervention (Chapter 1.3), including its environmental relevance and the contextual rationale for focusing on this behavior in the present studies.

- Do the authors refer to the literature most relevant to the research question at hand?

Relevant literature is cited, but only for an extremely small/reduced theoretical background. In line with my comments above, this should of course also be significantly expanded.

With response to the previous recommendations, we substantially expanded the theoretical background and integrated additional relevant literature.

- Are research questions well motivated/hypotheses adequately justified? Is the reasoning coherent?

Unfortunately, appropriately formulated hypotheses can only be found in study 2. But here too, the justifications for the assumptions are sometimes difficult to understand, as already noted, especially with regard to hypothesis 2: As tested by the authors later, the mediation assumption here presupposes that environmental attitude was influenced by the intervention - but why should a nudge have an influence on an attitude? In my view, this makes no sense considering the conception of nudge interventions (they are rather assumed to have a direct behavioral influence, but no cognitive effect).

We thank the reviewer for this important comment and agree that the theoretical rationale underlying the attitude-related hypotheses required further clarification. In response, we substantially revised the conceptual framing of the manuscript and clarified the distinction between affective (“prime-like”) and cognitive (“prompt-like”) mechanisms of pictorial warnings by discussing how pictorial warnings may not only elicit immediate affective reactions, but may also function as prompts that activate existing environmental knowledge, attitudes, and considerations at the moment of decision-making. In line with this reasoning, we now frame the analyses involving environmental attitudes as exploratory tests of a potential prompt-like mechanism rather than as evidence for stable attitude change caused by the nudge itself. To clarify this theoretical perspective, we substantially revised the relevant sections of the introduction and hypothesis derivation. Latter now states (page 9f., ll. 356-380):

“To better understand the mechanisms underlying pictorial warning effects, we examined whether exposure to the warning increases consumers’ awareness of the importance of avoiding plastic packaging for environmental welfare. This mechanism would be consistent with a prompt-like

function of pictorial warnings, in which effects arise through the activation and retrieval of environmental attitudes at the point of decision (e.g., Gemmecke et al., 2025; Moussaoui et al., 2020). While previous research has shown that pictorial warnings can elicit strong negative emotions that individuals are motivated to avoid (e.g., Fumagalli & Shrum, 2024; Hammond, 2011; Kranzbühler & Schifferstein, 2023), can also serve as sources of information that improve knowledge and understanding (Noar et al., 2016). To capture the latter potential prompt-like pathway, we focus on environmental attitudes as an exploratory outcome variable. [...] From this perspective, pictorial warnings may enhance the cognitive accessibility of environmental consequences at the point of decision, thereby activating existing environmental considerations that might otherwise remain inactive during consumption choices. Thus, this exploratory analysis provides initial evidence for a potential prompt-like function of pictorial warnings, in which they not only evoke affective responses (prime-like mechanism) but may also activate environmentally relevant knowledge and considerations during decision-making.”

In addition, we revised the labeling and presentation of the hypotheses across both studies to improve clarity and consistency. Specifically, the hypothesis in Study 1 is now explicitly labeled as Hypothesis A.1, while the hypotheses in Study 2 are labeled as Hypotheses B.1–B.3.

Furthermore, in view of the lack of theoretical background to explain the problem behavior, I find all considerations on the effect of the intervention and thus also the formulated hypotheses as a whole unfortunately difficult to understand.

We hope that the substantial revision of our theoretical background now provide a clearer foundation for the hypotheses and improve the overall comprehensibility of the proposed effects.

- Is the contribution of the present research to the existing literature made explicit?

That is difficult to say. The authors justify their contribution mainly by saying that there is research on the effect of pictorial nudges primarily in the health sector and not in the environmental sector; however, I do not (completely) share this view - in my view, there is a lot of similar research here (which unfortunately is not adequately reflected in the paper);

We appreciate the reviewer's point and agree that related research in the environmental domain exists and should be more comprehensively acknowledged. We have revised the manuscript accordingly to better situate our work within the broader literature. Please refer to Chapter 1.1 for a summary of the existing research in this field.

I think the contribution of the studies could be relevant, but more in the sense of preliminary studies as a basis for a new/further study in which the conceptual weaknesses of the current studies are specifically addressed.

Our primary intention is to contribute to the scientific discourse by examining whether a well-established intervention from the health domain, particularly pictorial warnings, can be meaningfully transferred to the context of pro-environmental behavior. In this sense, our studies are explicitly positioned as initial, exploratory steps that can inform and motivate subsequent research in this area. More specifically, our work aims to provide a first empirical assessment of the effectiveness and underlying mechanisms of pictorial warnings in the context of plastic consumption. Given that large-scale field studies in this domain are often resource-intensive, we see our experiments as a necessary preliminary step to evaluate whether such interventions are sufficiently promising to justify further investigation under real-world conditions. To clarify the intended contribution from the outset, we have revised the introduction as follows (page 4, ll. 106-110): „Across two online-experiments, we examine the effectiveness of environment-related pictorial warnings placed directly on the plastic packaging. In doing so, the present research provides initial evidence regarding the potential of pictorial warnings as a behavioral intervention tool within the environmental domain and offers a basis for future research in real sales contexts. “

- Have all scientific terms and concepts been explicitly defined?

I am very unsure whether the classification of the intervention carried out here as a “nudge” is actually appropriate. Shouldn't the illustrations used rather be classified as “prompts” because they communicate certain (problem) information? There should at least be an appropriate reflection on this issue (nudge vs. prompt) in the paper.

We thank the reviewer for this important conceptual comment, which helped us substantially refine the theoretical classification of pictorial warnings within behavioral intervention frameworks. In response, we added a new section (Chapter 1.2 Conceptualizing Pictorial Warnings within Behavioral Intervention Frameworks) that explicitly discusses the pictorial warnings in relation to nudges, prompts, and related intervention types. While we agree that pictorial warnings share important characteristics with prompts because they communicate problem-relevant information at the moment of decision-making, we retained the broader term “nudge” for two reasons. First, pictorial warnings are frequently discussed as nudging interventions in the existing literature, making this terminology more accessible and recognizable for readers. Second, we now explicitly follow the classification proposed by Wee et al. (2021), who conceptualize prompting, labeling, and priming as distinct nudging techniques in the context of pro-environmental behavior. Within this framework, pictorial warnings as used in the present research can primarily be understood as a form of labeling, while simultaneously operating through mechanisms associated with prompting and priming. Accordingly, the revised manuscript now provides a more differentiated conceptualization of pictorial warnings and explicitly reflects on their potential affective (“prime-like”) and cognitive (“prompt-like”) mechanisms. See Chapter 1.2 (page 6) for new conceptualization.

Furthermore, environmental attitude does not appear to me to be uniformly defined in the paper, either conceptually or with regard to the selected operationalizations - in Study 1, for example, a very old scale is used to measure environmental attitude in a rather general way and in Study 2, parts of the scale are replaced by very specific items related to plastic. Thus, there is a lack of an overarching/coherent definition and operationalization here.

We revised the theoretical introduction to provide a more explicit definition of environmental attitudes and their proposed role within the prompt-like mechanism framework as follows (page 10, ll. 366-380): “To capture this potential prompt-like pathway, we focus on environmental attitudes as an exploratory outcome variable. Environmental attitudes reflect individuals’ general evaluation of and commitment to environmental protection goals (e.g., Kaiser, 2021; Kaiser et al., 2011) and are partly grounded in environmental knowledge and awareness of environmental consequences (e.g., Bamberg & Möser, 2007; Kaiser & Fuhrer, 2003; Stern, 2000). Accordingly, increased awareness of environmental consequences may influence behavior indirectly via changes in environmental attitudes. From this perspective, pictorial warnings may enhance the cognitive accessibility of environmental consequences at the point of decision, thereby activating existing environmental considerations that might otherwise remain inactive during consumption choices.”

Furthermore, we now explicitly acknowledge in the General Discussion that environmental attitudes were operationalized differently across the two experiments, which limits the direct comparability of the findings and constrains conclusions regarding the proposed prompt-like effects (Page X, Line X): „In the present studies, environmental attitudes were included as a key construct but operationalized differently across experiments, limiting comparability and constraining conclusions regarding prompt-like effects.”

Methods:

- Is the research design suited to address the research question at hand?

With regard to the study groups (EG-CG design) basically yes, but according to my criticism of the theoretical background, the design is far too reduced with regard to the independent variables captured in the studies. I also find the measurement of the dependent variable in both studies very questionable (using only 1 item to measure the DV per study, for me, seems quite inappropriate in general; and, as also noted by the authors, especially in study 1 using an item examining participants’ purchasing

behavior with regards to purchasing for another person is extremely inappropriate).

We agree that the present design is relatively parsimonious with regard to the operationalization of both independent and dependent variables, and we acknowledge that this represents an important limitation of the current work. Apart from the already included acknowledgement of potential influences through the scenarios (lines 797-805), we also took the aspect of our 1-item dependent variable into account (see page 22, ll. 806-813): “Third, the present studies relied on relatively simple behavioral operationalizations involving binary choices between products. This approach was chosen to approximate realistic purchasing decisions involving plastic versus non-plastic alternatives. However, real consumer environments typically involve multiple competing products and repeated decisions. Future research could therefore employ more complex and repeated choice paradigms similar to previous studies on meat consumption (e.g., Hughes et al., 2023, 2024) or naturalistic online shopping paradigms (e.g., Taillie et al., 2023). “

- Is the procedure described at a level of detail that allows replication by others?

Unfortunately, no. I know that the authors have noted that they cannot show the original nudges in the paper due to copyright issues, but from my point of view this is a very big problem: Especially with regards to study 2, I unfortunately have no clear idea based on the text description what the plastic-unrelated nudge in particular looked like on the bottle.

Luckily, we were able to get the permission of the images' copyright-owners to show the images within a publication. Please refer to Figures 1 and 2 for the stimuli used.

I would also like to see the exact descriptions for the scenarios (i.e., exactly the texts from the questionnaire; unfortunately, I could not find these in the online material).

We added the scenario descriptions into the supplemental material in Appendices SA and SB (German version and close English translation).

I am also missing a few details from the actual data acquisition process: How long was the survey?

We added the survey duration for each experiment as follows:

- Experiment 1 (Page 10, ll. 397f.): “The experiment was implemented online with SoSci Survey (Leiner, 2019) and took 7.08 min on average ($SD = 2.91$).”
- Experiment 2 (Page 15, ll. 552f.): “The study was implemented online with SoSci Survey (Leiner, 2019) and took 8.16 min on average ($SD = 3.47$).”

Were there “no answer”-answering options?

None of the survey questions or selection procedures included a “no answer” option. We added this information for experiment 1 on page 11, ll. 419f. and for experiment 2 on page 16, ll. 582f.

When/ how were socio-demographic variables captured?

In both experiments, we assessed the socio-demographic variables at the beginning of the study (immediately after the informed consent was signed and language proficiency was assessed). In Experiment 1, we assessed age and gender, and in Experiment 2 age, gender and current primary occupation. We added this as follows in the manuscript:

- Experiment 1 (page 10f., ll.402ff.): “Participants then reported their age and gender before being randomly assigned (using the built-in randomization function in SoSci Survey) to either the experimental or control condition.”
- Experiment 2 (page 15, ll. 557ff.): “Participants then reported their age, gender, and current primary occupation before being randomly assigned (using the built-in randomization function in SoSci Survey) to one of three experimental conditions.”

Were there any attention check measures?

No attention checks were included in the survey. We added this information for both experiments on page 11, ll. 420f. and page 16, ll. 583f.

Only in study 2 was the exclusion of 2 respondents due to age described, was there otherwise no data cleansing or a corresponding check?

In both experiments, participants were required to meet the study-specific minimum age criterion and to have sufficient German language proficiency. These eligibility criteria were assessed at the beginning of the survey. Participants who did not meet these criteria were automatically directed to the end of the survey and therefore were not included in the final dataset. Apart from this eligibility screening, no additional data cleansing procedures were conducted, and all fully completed responses were retained for analysis. In Experiment 2, however, two participants were excluded because they later reported an age below the minimum eligibility criterion when asked to indicate their exact age, despite initially confirming that they fulfilled the participation requirements at the beginning of the survey. To clarify this procedure, we added the following sentences to the manuscript

Experiment 1 (page 10, ll. 398-402): “After providing online written consent, eligibility criteria of a minimum age of 18 years and sufficient German language proficiency (B1 level) were assessed. Participants who did not meet these criteria were automatically directed to the end of the survey and were therefore not included in the final dataset.”

Experiment 2:

- Page 15, ll. 553-557): After providing online written consent, eligibility criteria of a minimum age of 16 years and sufficient German language proficiency (B1 level) were assessed. Participants who did not meet these criteria were automatically directed to the end of the survey and were therefore not included in the final dataset.
- Page 14, ll. 526f.): “Two participants were excluded because they reported an age below the minimum participation age, although the study was restricted to eligible participants.”

And when/ how were the subjects randomized to the study groups?

Randomization occurred automatically within the survey prior to the presentation of the choice task. We made this clearer in the manuscript as follows:

- Experiment 1: “Participants then reported their age and gender before being randomly assigned (using the built-in randomization function in SoSci Survey) to either the experimental or control condition. All participants subsequently read the same scenario in which they were asked to imagine that they went food shopping for their 80-year-old neighbor and had a fixed budget of 20 €. [...] The only difference between conditions was the visual presentation of the choice options: In the experimental condition, participants could choose between a blank textile bag and a plastic bag with the pictorial warning, and in the control condition, they could decide between a blank textile and a blank plastic bag.” (p. 10f., ll. 402-417)
- Experiment 2: “After providing online written consent, eligibility criteria of a minimum age of 16 years and sufficient German language proficiency (B1 level) were assessed. Participants who did not meet these criteria were automatically directed to the end of the survey and were therefore not included in the final dataset. Participants then reported their age, gender, and current primary occupation before being randomly assigned (using the built-in randomization function in SoSci Survey) to one of three experimental conditions. Participants subsequently read a scenario in which they were asked to imagine shopping for a dinner with friends, including water in either a glass or a plastic bottle (see Appendix SB for the full scenario description). Across all conditions, the scenario and decision context were identical. The only difference between conditions was the type of pictorial warning applied to the presented plastic bottle” (p. 15, ll. 557-565).
- Is the operationalization of psychological constructs described in a clear way?

All items are listed in tables, but as I said, there is a strong deviation in the measurement between study 1 and 2 in the scale for measuring environmental attitude, which is highly critical. In addition, there is no information on the quality of the scales formed.

We mentioned this limitation in the discussion section as follows:

- Page 20f., ll. 748-754: “In Experiment 1, exposure to pictorial warnings was associated with more

positive environmental attitudes compared to the control condition, suggesting a potential increase in the accessibility of environmental knowledge and awareness. However, this effect was not replicated in Experiment 2. Importantly, the two experiments employed different operationalizations of environmental attitudes, limiting the comparability of the findings across studies and should therefore be interpreted with caution.”

- Page 23, ll. 872-875: “Addressing this question requires more differentiated and psychometrically refined measures of underlying mechanisms. In the present studies, environmental attitudes were included as a key construct but operationalized differently across experiments, limiting comparability and constraining conclusions regarding prompt-like effects.”

Furthermore, we added for all scales used the internal consistencies:

- Experiment 1, page 10, ll. 395f.: “For the exploratory analysis, we assessed the environmental attitude operationalized by the attitude scale of the System for Capturing Environmental Consciousness (Schahn et al., 1999, see Table SC1). The scale showed very good internal consistency, with Cronbach’s $\alpha = .91$.”
- Experiment 2:
 1. Page 14., ll. 536f.: “Environmental attitude was measured by 12 items, adapted from the Environmental Concern Scale (Weigel & Weigel, 1978) and the Plastic Awareness Scale (Mathur & Singh, 2019; see Table SC2). The scale showed strong internal consistency, with Cronbach’s $\alpha = .89$.”
 2. Page 14, ll. 546f.: “Internal consistency was good to excellent for both scales, with Cronbach’s $\alpha = .87$ for glass-related shame and Cronbach’s $\alpha = .93$ for plastic-related shame.”
 3. Page 15, ll. 549f.: “Social desirability was examined using the 7-item scale for measuring social desired responsiveness (Satow, 2012). Internal consistency relatively low, with Cronbach’s $\alpha = .66$.”
- 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.

Although the sample sizes are well justified, as already mentioned above, the sampling process is not described at a sufficient level of detail. In addition to the issues already mentioned above, it would also be important to obtain more information on the socio-demographics of the sample in order to better classify the findings (the paper only provides information on the age and gender of the participants).

We have revised the manuscript to provide a more detailed description of the sampling process, as requested earlier. Regarding socio-demographic information, we acknowledge the reviewer’s concern. However, additional socio-demographic variables were not assessed in this study, as data collection was intentionally limited to the key variables required to address the primary research questions. The present study was designed as an initial test of the general effectiveness of pictorial warnings in this context, rather than an exploratory investigation of moderators or individual differences. We agree that more fine-grained socio-demographic information (e.g., education, income) would be valuable to better understand for whom such interventions are most effective. This represents an important direction for future research, which we now explicitly highlight in the Discussion section (see page 23, ll. 882-888): “Finally, future research should examine for whom pictorial warnings are most effective. The present studies served as an initial test of pictorial warnings in the context of plastic packaging and therefore included only limited socio-demographic information. More detailed assessments of factors such as education, income, pro-environmental attitudes, and political orientation may help identify subgroups that respond particularly strongly or weakly to such interventions (e.g., Bamberg & Möser, 2007; Klein et al., 2019; Wyss et al., 2022).”

Results:

- Is the chosen analysis strategy clearly described and suitable for addressing the research question?

In view of the measurement (in particular the 1-item measurement for the DV per study), the analysis seems appropriate. However, logistic regressions etc. naturally only provide comparatively weaker empirical evidence than other analyses would do if it had been possible to form an interval-scaled DV per study. I therefore propose, as already described at the beginning of my review, to conduct a new, more comprehensive study with optimized scales for measuring IVs and DVs, in which the quality of different analysis methods is also taken into account.

We hope that our study, together with the now more extensive discussion of limitations and future directions, provides a useful reference point for future research and highlights the need for more fine-grained measurement and analytical approaches in this domain.

- Are all tables and figures necessary, informative, and comprehensible?

As already mentioned, pictures of the tested nudges would be extremely important to get a really clear idea of what was really done here.

Please refer to Figure 1 and 2 for the used stimuli.

- Is the description of results separated from their interpretation?

Yes.

- Is the description of data and statistical hypothesis tests complete? Are all relevant tests described and do these descriptions include test statistics, exact p-values, and effect sizes?

Yes.

Discussion:

- Are all conclusions corroborated by the presented material? Do they follow from the results?
- Are speculations acknowledged as such?
- Are results integrated into the existing literature?
- Are the limitations of the reported study and the generalizability of the results to other populations and situations adequately discussed?

I would like to give an overall assessment here: In view of the already comprehensively described weaknesses in the theoretical background of the paper, it is of course hardly surprising that the problems existing there are also reflected in the discussion section. Here, too, the reflection on the findings is rather superficial in my view. There is also a lack of classification of the findings in important previous research on plastic consumption and also on the impact evaluation of comparable intervention approaches in the field of the promotion of pro-environmental consumption behaviors. Unfortunately, references are again only made to the health sector. In view of the many conceptual and methodological weaknesses of the two studies conducted, I also find the reflection on the limitations of the studies in the paper far too rough and superficial.

We thank the reviewer for this clear and comprehensive assessment, which provided important guidance for revising the manuscript. In response to this comment, as well as the feedback from the other reviewers, we have substantially revised the General Discussion. Specifically, we now provide a more critical and differentiated discussion of the findings, strengthen the integration with prior research and comparable pro-environmental interventions, and more clearly distinguish theoretical contributions, practical implications, and limitations. We hope that the revised General Discussion (starting on page 20) now meets the reviewer's expectations and provides a more appropriate and balanced interpretation of the results.

Practical impact:

- Have the implications of the present work for the application of environmental psychology, practitioners, and the general public been made explicit?
- Are these implications specific and do they follow from the presented results?

- Are limitations of applicability discussed as well?

Here, too, I would like to give an overarching assessment: Due to the severe conceptual and methodological weaknesses of the studies conducted, I unfortunately cannot grant the findings and the paper in its entirety any real practical relevance. Particularly with regard to possible practical implications of a new and comprehensively revised study idea on the same topic, as proposed, I recommend above all discussing the practical implications of such a study, especially with regard to possible reactance and habit effects in the effects of pictorial-based prompts/ nudges (as already mentioned above with regard to the theoretical background).

We thank the reviewer for this overarching assessment. In response, we substantially revised the General Discussion and added a clearly separated subsection on practical implications. In this section, we now more explicitly outline the relevance of pictorial warnings for different contexts. In addition, as suggested before, we address limitations to applicability more explicitly in the Limitations section, including considerations of potential reactance and habit-related boundary conditions of pictorial warning interventions (see lines 888-897 and lines 787-796).

Open science:

- Have the authors reported all measures, conditions, data exclusions, and how they determined their sample sizes?
- As noted above, some details are missing from the description.

We hope that our revisions address the previously missing details and improve the transparency and reproducibility of the reported study.

- Do you know whether the authors preregistered their data? If yes, can you access the preregistration? Are there any unmentioned deviations from the preregistration?

Study 2 was pre-registered (the link was not provided for reasons of anonymity, which is understandable); the materials were uploaded to OSF, but the folders in the system are currently empty. Unfortunately, I was therefore unable to view the material. But maybe I haven't found the right folders in the system!?

We thank the reviewer for checking the OSF materials. We are sorry that the structure of the OSF repository may have caused confusion. The materials are available in view-only mode, and the individual components need to be opened separately to access the files (despite the lock icon indicating restricted editing rights, viewing access is enabled). We have re-checked the link and confirmed that all materials are fully accessible as intended.

- 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?

No - maybe this should only happen after the review process? Or maybe I haven't found the right folders in the system!? I'm not sure about this!?

We have uploaded all relevant data to OSF in the respective project repository and can be accessed in view-only mode. We are sorry that access may have initially been unclear due to the structure of the OSF project; the data files are located within the designated data folder and may need to be opened via the respective components. We have re-checked the repository and confirm that all files are accessible as intended. We hope this resolves any issues in locating and reviewing the dataset.

Response to Reviewer B

We thank Reviewer B for the positive evaluation of our work. We also appreciate the reviewer's observation that the effectiveness of pictorial warnings should ultimately be examined in real sales contexts. In response to the related concerns raised by Reviewers A and C regarding the use of hypothetical online scenarios, we now more

explicitly highlight that the present study provides a foundation for future research in real sales contexts.

For example, we now state in the introduction: “Across two online-experiments, we examine the effectiveness of environment-related pictorial warnings placed directly on the plastic packaging. In doing so, the present research provides initial evidence regarding the potential of pictorial warnings as a behavioral intervention tool within the environmental domain and offers a basis for future research in real sales contexts” (page 4, l. 106-110).

In the Discussion we say: “Further research is needed to investigate their effectiveness across different environmental behaviors, their interaction with individual and contextual factors, and their applicability in real sales contexts” (page 25, ll. 951ff.).

Response to Reviewer C

We thank the reviewer for this very helpful suggestion and for pointing us to the recent work by Gemmecke et al. (2025), which we have now included in the revised manuscript. In response, we substantially strengthened the theoretical framing of pictorial warnings by more explicitly linking them to intervention research in environmental psychology. Specifically, we added a new subsection (Chapter 1.2: Conceptualizing Pictorial Warnings within Behavioral Intervention Frameworks), in which we discuss the relationship between nudges and prompts and clarify their conceptual overlap and distinctions in terms of underlying psychological mechanisms. While we acknowledge the strong conceptual overlap with prompts as discussed in environmental psychology, we retained the broader term “nudge” for two reasons: (1) pictorial warnings are widely discussed in the literature under the umbrella of nudging, which enhances terminological consistency and accessibility for readers, and (2) we follow the classification proposed by Wee et al. (2021), who distinguish prompting, labeling, priming, and related strategies as subtypes of nudging in pro-environmental contexts. Within this framework, pictorial warnings as implemented in the present studies are primarily conceptualized as a form of labeling, while also operating through mechanisms associated with prompting and priming. Accordingly, the revised manuscript now provides a clearer and more differentiated conceptualization of pictorial warnings and their underlying mechanisms (see Chapter 1.2, p. 6), which also clarifies the rationale behind their classification as nudges and their proposed scalability as an intervention approach.

1. The “General Discussion” section should be structured more clearly. It would be helpful to distinguish between the three topics “Summary of results and theoretical contribution,” “Limitations and future studies,” and “Practical implications” and to mark them with subheadings.

We share this observation and structured the General Discussion accordingly.

Overall, the structure should address the limits of generalizability and transferability of the results in more detail. In this regard, the aversive nature of the two nudges in Experiment 2 is not sufficiently reflected. All three aversive nudges used in Experiments 1 and 2 visualize a threat to animals. This activates a normative frame of reference of animal protection or animal welfare. This topic should be addressed in the general discussion and could possibly be included in the introduction. The following issues should be considered: Is there a risk of confusing environmental protection and animal protection/welfare due to the stimulus material used? How do these two normative perspectives relate to each other? How can this be addressed in a more differentiated manner in future studies?

We thank the reviewer for this important reflection on the generalizability and normative framing of the stimulus material. In response, we substantially revised the General Discussion to more explicitly address these issues. Specifically, we now include a dedicated and more critical reflection on the potential overlap between environmental and animal welfare frames induced by the pictorial warnings. We clarify that while these domains are related, they are conceptually distinct and may differentially shape psychological

responses and behavioral effects. Accordingly, we outline directions for future research to disentangle these mechanisms by systematically varying pictorial content and comparing environmental, animal welfare, and alternative approaches (see General Discussion, pp. 22f., ll. 814-853): “Another important limitation concerns the specific content and normative framing of the pictorial warnings used in the present studies. All warning images depicted animals harmed by pollution or decay, which may have activated not only concerns about plastic pollution in the context of environmental welfare but also empathy toward animals and animal welfare concerns. Although these domains substantially overlap in the context of plastic pollution, they remain conceptually distinct. Environmental protection primarily relates to ecosystems, resource use, pollution, and climate-related consequences, whereas animal welfare focuses more directly on the suffering and moral status of individual animals (e.g., Ammann et al., 2024; Broom, 2019; Klink-Lehmann et al., 2023). Prior research suggests that animal welfare concerns can exert particularly strong effects on consumer decision-making (e.g., Ammann et al., 2024; Kranzbühler & Schifferstein, 2023). Consequently, the behavioral effects observed in the present studies may not be attributable exclusively to environmental concerns, but may also partly reflect reactions related to animal welfare. This distinction is relevant because prior research suggests that different warning contents may evoke distinct psychological processes despite similar behavioral outcomes. For example, Kranzbühler and Schifferstein (2023) found that environmental, health, and animal welfare warnings did not differ in behavioral effects, but did elicit differences in emotional responses, with health warnings inducing weaker negative affect. Similarly, Hughes et al. (2023) found that health-, climate-, and pandemic-related pictorial warning labels all reduced meat meal selection compared to a control condition, with no differences between warning types. At the same time, it is important to note that these studies combined pictorial warnings with textual warning messages, leaving unclear the extent to which effects are driven specifically by pictorial information or whether similar effects would emerge with text alone. Koch et al. (2022) suggest that in combined text-and-image warning labels, the graphical component mainly elicits affective avoidance motivation, whereas the textual component primarily provides information and educates consumers. This is noteworthy, as evidence from text-only warning studies indicates a potential advantage of health-related warning messages compared to environmentally framed messages (Taillie et al., 2022; Van Asselt et al., 2022), whereas the previously mentioned studies combining pictorial and text warnings did not reveal consistent differences between health- and environment-related framings (Hughes et al., 2023; Kranzbühler & Schifferstein, 2023). These findings raise the question of whether pictorial information in the context of pro-environmental behavior may contribute additional or distinct effects beyond text warning alone. Future research should therefore directly compare pictorial, textual, and combined warning formats, as well as different pictorial contents, to better isolate their relative effectiveness and underlying psychological mechanisms.”

In this context, connections can also be made to health psychology, which, from a normative perspective, is focused on self-protection and is therefore primarily egoistic. The explanations in lines 471 to 478, which already address the differences between health promotion and environmental protection, can also be integrated here.

We thank the reviewer for this helpful suggestion. We agree that the comparison between health-related and environmentally relevant behaviors provides an important additional perspective. Due to revisions in the structure of the manuscript, we have currently integrated this argument in a different section of the General Discussion where it fits more directly with the respective lines of reasoning. However, we are of course open to relocating this passage if the reviewer or editor considers a different placement more appropriate.

Currently, we state on page 21, ll. 760-769: “In contrast to many health-related behaviors, environmentally relevant behaviors often provide less direct and less immediate personal benefits (Lorenzoni et al., 2007).

While quitting smoking primarily protects one’s own health, reducing plastic consumption contributes to collective and long-term environmental outcomes that may appear psychologically distant from the individual. In this regard, pictorial warnings may help make otherwise abstract environmental consequences

more concrete and emotionally salient. Accordingly, Boomsma et al. (2019) argues that visual imagery can increase the salience of long-term environmental goals and motivate environmentally relevant action by making environmental consequences more imaginable and concrete.”

In addition, the specific form of environmental behavior under investigation, which is only briefly mentioned in lines 504/505, should be explained. For the target behavior of reduced use of plastic bags and bottles, clear and relatively easy-to-implement behavioral alternatives are available, such as cloth bags and plastic bottles. For what other types of environmental behavior can pictorial warnings be expected to have little or no effect?

We thank the reviewer for this helpful suggestion. In response, we clarified and expanded the description of the target behavior in the revised manuscript. Specifically, we now introduce plastic packaging use in greater detail already in the Introduction (Section 1.3: Plastic Packaging Use as the Behavioral Context of the Present Research), thereby more clearly outlining the nature and scope of the focal behavior. In addition, we further elaborate in the General Discussion on the types of environmental behaviors for which pictorial warnings may be particularly suitable or less effective (see pp. 24f, ll. 921-940): “

- “While pictorial warnings may interrupt habitual consumption processes, they are likely to be less effective for behaviors involving substantial financial investments, infrastructural constraints, or established ownership patterns (cf. Wyss et al., 2022). For example, interventions at the point of decision may have limited impact on private car use once a vehicle has already been purchased and integrated into everyday routines, as such behaviors are often constrained by mobility needs, infrastructure, and prior financial commitments. Consistent with this view, research on text-based warning labels suggests that intervention effectiveness may depend on habit strength; for example, Ding et al. (2024) observed effects primarily among individuals with moderate habit strength. Overall, the present findings and prior evidence indicate that pictorial warnings may be particularly suitable for “moment-of-choice” behaviors in which consumers can easily switch between directly available alternatives. Beyond plastic packaging, pictorial warnings may therefore be applicable to other waste- and consumption-related domains, including recycling behavior, plastic waste reduction (Luo et al., 2022), and single product–level consumption decisions, such as choosing meat products at the point of purchase (e.g., Hughes et al., 2023). Such interventions may also prove relevant in consumer domains characterized by frequent, low-threshold purchasing decisions, such as fast fashion or certain electronic products.”

In addition, an assessment of the effect sizes ($Z: 349/350$) would be informative for readers interested in the use of aversive pictorial warnings compared to other behavioral interventions.

We added the following classification of the effect sizes for Experiment 2 as follows: “The corresponding odds ratios indicated effects of medium magnitude according to the benchmarks proposed by Chen et al. (2010), with the converted effect sizes corresponding to $d = 0.72$ and $d = 0.54$, respectively” (pp. 16f., ll. 595-598). To be consistent, we also added such classification for Experiment 1: “Based on the guidelines by Chen et al. (2010), the magnitude of the observed effect can be classified as small-to-medium” (page 12, ll. 435f.).

As a suggestion, the following points should be revised to improve the quality of the manuscript content:

1. The term “plastic consumption” is very broad. Throughout the text (and possibly also in the title), it could be clarified as “reduction of plastic packaging.”

We appreciate this suggestion and agree that the term “plastic consumption” is overly broad in the present context. To enhance clarity and precision, we have revised the terminology throughout the manuscript to specifically refer to the “reduction of plastic packaging use.”

2. There is a hypothetical assumption about Experiment 1 (see lines 174, 183), even though the analysis is

exploratory in nature. Please explicate this hypothetical assumption as in Experiment 2 on page 8.

We thank the reviewer for this helpful observation. In response, and also in line with Reviewer A's comments, we revised the derivation of the hypothesis in Experiment 1 to improve clarity (see pp. 9f, ll. 352-380):

“Based on this reasoning, we hypothesized that individuals choose a reusable textile bag more often when a single-use plastic carrier bag was labeled with a pictorial warning compared to an identical plastic bag without such a warning (Hypothesis A.1). To better understand the mechanisms underlying pictorial warning effects, we examined whether exposure to the warning increases consumers' awareness of the importance of avoiding plastic packaging for environmental welfare. This mechanism would be consistent with a prompt-like function of pictorial warnings, in which effects arise through the activation and retrieval of environmental attitudes at the point of decision (e.g., Gemmecke et al., 2025; Moussaoui et al., 2020). While previous research has shown that pictorial warnings can elicit strong negative emotions that individuals are motivated to avoid (e.g., Fumagalli & Shrum, 2024; Hammond, 2011; Kranzbühler & Schifferstein, 2023), they have also been identified as sources of information that can improve knowledge and understanding (Noar et al., 2016). To capture this potential prompt-like pathway, we focus on environmental attitudes as an exploratory outcome variable. Environmental attitudes reflect individuals' general evaluation of and commitment to environmental protection goals (e.g., Kaiser, 2021; Kaiser et al., 2011) and are partly grounded in environmental knowledge and awareness of environmental consequences (e.g., Bamberg & Möser, 2007; Kaiser & Fuhrer, 2003; Stern, 2000). Accordingly, increased awareness of environmental consequences may influence behavior indirectly via changes in environmental attitudes. From this perspective, pictorial warnings may enhance the cognitive accessibility of environmental consequences at the point of decision, thereby activating existing environmental considerations that might otherwise remain inactive during consumption choices. Thus, this exploratory analysis provides initial evidence for a potential prompt-like function of pictorial warnings, in which they not only evoke affective responses (prime-like mechanism) but may also activate environmentally relevant knowledge and considerations during decision-making.”

3. Due to their central importance to both experiments, the images used on the bags and bottles should be presented. This would allow for a better assessment of their content and graphic quality.

We are pleased to inform you that we have obtained the necessary agreements from the copyright owners to present the images used in both experiments. See Figure 1 and 2 for the used stimulus material.

4. In Experiment 2, participants were given information about the deposit, weight, and price per liter for plastic and glass bottles. To what extent is this information intended to support an “informed decision” (line 335)? Are these three values intended to illustrate the environmental relevance of the decisions? Was it verified whether participants accessed this information or took it into account in their decision?

The information on deposit, weight, and price per liter was included primarily to enhance the external validity of the experiment by approximating the practical trade-offs consumers typically face. Specifically, it was intended to reflect realistic choice conditions within our fictional scenario by incorporating common barriers associated with choosing glass bottles, most notably greater physical effort (due to weight) and, in real-world contexts, often higher costs compared to plastic bottles. In addition, the deposit characteristics corresponded to the actual bottle-return system in Germany at the time of data collection, thereby further grounding the decision context in a familiar real-world setting. In this sense, the term “informed decision” refers not to conveying environmental impact, but to presenting participants with reality-based options that reflect everyday consumption trade-offs. Importantly, this information ensured that choosing glass bottles was not perceived as equally convenient as choosing plastic bottles, which would be unrealistic.

We have revised the procedure section accordingly: “We changed the description within the procedure as follows: “Based on actual water bottles from German supermarkets, information about the deposit amount (plastic = 0.25 €, glass = 0.15 €), weight (plastic = 1.4 kg, glass = 1.7 kg) and price per liter (plastic = 0.94 €,

glass = 0.94 €) were provided to approximate a realistic decision context. This information ensured that choosing glass bottles was not perceived as equally convenient as choosing plastic bottles, as would be unrealistic, but instead involved the kinds of practical disadvantages (e.g., greater weight) that consumers encounter outside the experimental setting“ (pp. 15f., ll. 573-579).

We did not directly assess whether participants accessed or actively used this information in their decision-making process. However, as all information was held constant across experimental conditions, any potential influence of these attributes would have affected participants equally across groups. Therefore, it is unlikely that this aspect systematically biased the observed effects between conditions. We added the following footnote 3 on p. 16: “It was not assessed whether or how participants attended to or made use of this information in their decision-making; however, the information was held constant across conditions.”

Comments by Reviewer A

First of all, I would like to thank the authors for their tremendous effort in revising their article! Overall, the revision is truly very well done. I am very impressed by how much effort the authors put into the revision. Through their thorough revision, they have not only meaningfully addressed nearly all the points I raised in the first round of review, but have also largely dispelled my fundamental concerns regarding the publication of both studies (without further empirical data).

Of course, the somewhat more “preliminary” nature of the studies remains, but in my view, the authors now present and communicate this in a much more appropriate and transparent manner, making the studies’ “placement” within the research field seem much more coherent. The derivation of the overarching research questions and hypotheses for both studies is now also presented in a very comprehensive and clearly understandable way. It’s great to see how much the paper has improved through the review process.

I did notice a few minor points that could use further revision (see below for details), but once these are addressed, I believe nothing will stand in the way of the paper’s publication.

Minor issues for a (final) revision:

- Line 60: I would prefer to use the term “Teilnehmende” rather than “Erwachsene,” since “Erwachsene” is a somewhat atypical choice of wording – at least if there isn’t another sample group consisting of children, adolescents etc..
- Line 433 – 434: Here is a line break that should be removed.
- Line 456: I think it would be appropriate to explain/ justify here why the alpha level was set at .10 instead of the more common .05 (as in Experiment 2).
- Line 573 – 576: I think it would also be appropriate to explain/ justify here why another scale was used for the measurement of environmental attitude in Experiment 2 compared to the scale, which was used in Experiment 1.
- Line 805 – 808: As noted above, it would be important to know why the scales were changed between the two studies – since it is well known that this limits the internal validity of the findings. So why was this approach chosen?
- Line 871 – 872: In addition to the aspects already discussed, for me, the “maggot nudge” particularly problematic – specifically with regard to the external validity of the study. In terms of internal validity and the central research question in Experiment 2, it’s an absolutely appropriate choice; however, I wonder whether it might have somehow confused the participants in that group, since one might well wonder why there was this unpleasant label on the plastic bottle, which presumably instinctively led to rejection and thus very directly

suggested that this bottle-option should not be chosen (I'm referring here to a distorting effect beyond "normal" social desirability). In my view, there should have been a meaningful context or cover story for the label to prevent this potential bias. Therefore, I would suggest to discuss this issue with regards to implications for future studies.

- Line 919 – 920: I think that future studies should also take positive emotions into account – d also with a view to comparing the effects of induced negative emotions versus positive emotions.
- Line 961/ referring to practical implications: From a practical standpoint, it's important to note that – especially when it comes to images that trigger negative emotions – one should naturally keep in mind that these cannot/ should not simply be displayed in real-life settings or on everyday products. Even if regulations similar to those for tobacco products were in place here, a key difference is that tobacco products are explicitly intended only for an adult audience and are or at least should not (be) readily accessible to all customers in supermarkets and similar retail settings. With everyday products, such as beverages, etc., however, the situation is different: Couldn't this potentially lead to issues regarding the protection of children and adolescents? Of course, it is not the authors' job to offer a direct solution to this problem. However, I think it is important to at least address this issue.

Recommendation: Revisions Required

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Review Round 3

Response Letter to Review Round 2

Dear Anke Blöbaum, dear reviewers,

Thank you for acknowledging our previous revision and for inviting us to submit a minor revision of our manuscript. We have carefully addressed each of your remaining comments and hope that we have addressed them adequately. Below, we reproduce your remarks followed by our point-by-point responses (in **magenta**).

As a result of the revisions, we had to reorder the figures and tables. We hope that this new arrangement is satisfactory. If not, we would be happy to revise the order according to your preferences.

Thank you very much for your time and consideration.

Response to the editor

1. Please make any changes to the anonymised version of the manuscript in the unlikely event that we should need to send the document to one of the reviewers again.
 - **We made changes in the revised (and anonymized) manuscript and highlighted (formatted in bold in the following section of text) the new changes.**
2. On page 12, an author's name is misspelt in the reference: it should be Kahneman, not Kahnemann (correct in the reference list)
 - **Corrected.**
3. You use 'e.g.' or 'cf.' unusually frequently in your references. Whilst this is technically permissible under APA style, I would like to ask you to check here whether it is always appropriate or necessary. 'e.g.' refers to a list that is given by way of example and is therefore not exhaustive. Does this suggest that, otherwise, all relevant works

are generally listed in full?

What exactly is the difference between simple references and (cf., ...)?

- Thank you for drawing our attention to this issue.

i. Use of “e.g.”

Our intention in adding “e.g.” was to signal that the cited studies were illustrative rather than exhaustive. We agree that our usage was both unusually frequent and occasionally inconsistent. We have therefore reviewed every instance and retained “e.g.” only where it is essential to indicate an illustrative list; in all other cases we have removed it so that citations now follow standard practice.

ii. Use of “cf.”

On revisiting the APA guidelines, we realized we had conflated the English “cf.” (“compare”) with the German “vgl.”, which we had been using to introduce sources that support our reasoning only indirectly. Because this application does not align with APA style and may confuse readers, we have removed the “cf.” marker while retaining the corresponding citations.

4. Please use the same font size for the notes accompanying the figures as for the tables; in both cases, use font size 9.

- We corrected the font size in the manuscripts and the supplementary material. We also changed the font in the supplemental material file to EB Garamond, as in the manuscript template. If a different font is preferred, we can change it again.

Response to Reviewer A:

Minor issues for a (final) revision:

- Line 60: I would prefer to use the term “Teilnehmende” rather than “Erwachsene,” since “Erwachsene” is a somewhat atypical choice of wording – at least if there isn’t another sample group consisting of children, adolescents etc..
 - We changed the term “Erwachsene” to “Teilnehmende“, and accordingly in the English abstract “adults” to “participants”. Now, it states:
 - (p. 2, ll. 24-27): Experiment 1 ($N = 289$ **participants**) explored the effect of an environmental pictorial warning (i.e., a seal suffocating in a plastic bag) on the choice of plastic bags within a fictitious shopping scenario. Experiment 2 ($N = 551$ **participants**) investigated whether an environment-unrelated pictorial warning (i.e., a dead fish infested by maggots) would lead to the same effects on plastic bottle choice as an environment-related pictorial (i.e., a dead fish with a plastic bottle in its mouth).
 - (p. 2f., ll. 58-63): “Experiment 1 ($N = 289$ **Teilnehmende**) untersuchte den Effekt eines umweltbezogenen Schockbilds (eine in einer Plastiktüte erstickende Robbe) auf die Wahl von Plastiktüten in einem fiktiven Einkaufsszenario. Experiment 2 ($N = 551$ **Teilnehmende**) prüfte, ob ein nicht-umweltbezogenes Schockbild (ein toter Fisch mit Madenbefall) ähnliche Effekt auf die Wahl von Plastikflaschen hat wie ein umweltbezogenes Schockbild (ein toter Fisch mit einer Plastikflasche im Maul).“
- Line 433 – 434: Here is a line break that should be removed.
 - Thank you for this observation. We removed this break.
- Line 456: I think it would be appropriate to explain/ justify here why the alpha level was set at .10 instead of the more common .05 (as in Experiment 2).
 - Thank you for this comment. The original rationale for using an alpha level of .10 in Experiment 1 was that the main analyses tested a priori directional hypothesis. In Experiment 2, however, we adopted the

conventional alpha level of .05 as a more conservative criterion. Upon reflection, we agree that employing different significance thresholds across the two experiments may be confusing to readers. Furthermore, because Experiment 1 was not preregistered whereas Experiment 2 was, we believe that applying the conventional alpha level of .05 consistently across both experiments provides a more transparent and coherent basis for inference. We have therefore revised the manuscript accordingly. Importantly, this change does not affect the interpretation of the results or the conclusions drawn from the study. The manuscript now states for Experiment 1 (see page 12, ll. 424f.): **“An alpha level of .05 was employed for all statistical analyses.”**

- Line 573 – 576: I think it would also be appropriate to explain/ justify here why another scale was used for the measurement of environmental attitude in Experiment 2 compared to the scale, which was used in Experiment 1.
 - Thank you for this suggestion. In Experiment 1, environmental attitude was included in an exploratory manner to capture a broad, prompt-like pathway through which pictorial warnings may increase the cognitive accessibility of environmental consequences at the point of decision. Accordingly, we used the System for Capturing Environmental Consciousness scale (Schahn et al., 1999), reflecting overall environmental concern and commitment. Experiment 2 was designed to test a more specific mediation mechanism focusing on plastic-related decision contexts. To ensure alignment between the hypothesized mechanism and its operationalization, we therefore employed a more content-specific measure of environmental concern related to plastic pollution, which more closely captures plastic-relevant considerations assumed to be activated by plastic-related pictorial warnings. We have clarified this rationale in the revised manuscript as follows (see page 13, ll. 492-502):
 - **“To explore how pictorial warnings influence pro-environmental decision-making, we examined environmental attitude as a potential mediator reflecting the cognitive accessibility of environmental consequences at the point of decision. Experiment 1 provided initial exploratory evidence for the proposed prompt-like mechanism, showing stronger environmental attitudes in the pictorial warning condition compared to the no-nudge condition. In this experiment, environmental attitude was assessed using a broad measure of general environmental concern (Schahn et al., 1999). In Experiment 2, we employed a more content-specific measure of environmental attitude related to plastic pollution (Weigel & Weigel, 1978; Mathur & Singh, 2019), which better captures plastic-relevant considerations assumed to be activated by plastic-related pictorial warnings. We hypothesized in Experiment 2 that a plastic-related aversive pictorial warning activates environmental attitudes, which in turn increases the probability of choosing the glass instead of the plastic bottle (Hypothesis B.2). This mediation effect was not expected in the conditions containing no nudge or the plastic-unrelated aversive pictorial warning.”**
- Line 805 – 808: As noted above, it would be important to know why the scales were changed between the two studies – since it is well known that this limits the internal validity of the findings. So why was this approach chosen?
 - We added the following rationale in this section (see page 21, ll. 752-766): “Turning to prompt-like mechanisms, the present findings provide only limited and inconsistent evidence for more deliberative mechanisms. In Experiment 1, exposure to pictorial warnings was associated with more positive environmental attitudes compared to the control condition, suggesting a potential increase in the accessibility of environmental knowledge and awareness. However, this effect was not replicated in Experiment 2. **Importantly, environmental attitudes were operationalized differently across the two experiments. Whereas Experiment 1 employed a broad measure of general environmental concern as an exploratory assessment (Schahn et al., 1999), Experiment 2 used a more content-specific measure of plastic-related environmental attitudes (Weigel & Weigel, 1978; Mathur & Singh, 2019) to better align with the hypothesized mediation mechanism.**

Although this refinement improved the conceptual correspondence between the measure and the hypothesized process, it also limits the direct comparability of the findings across studies. Consequently, conclusions regarding the role of environmental attitudes as a prompt-like mechanism should be interpreted with caution.”

- Line 871 – 872: In addition to the aspects already discussed, for me, the “maggot nudge” particularly problematic – specifically with regard to the external validity of the study. In terms of internal validity and the central research question in Experiment 2, it’s an absolutely appropriate choice; however, I wonder whether it might have somehow confused the participants in that group, since one might well wonder why there was this unpleasant label on the plastic bottle, which presumably instinctively led to rejection and thus very directly suggested that this bottle-option should not be chosen (I’m referring here to a distorting effect beyond “normal” social desirability). In my view, there should have been a meaningful context or cover story for the label to prevent this potential bias. Therefore, I would suggest to discuss this issue with regards to implications for future studies.
 - We agree that the use of the “maggot nudge” in Experiment 2 may raise questions regarding external validity, particularly with respect to how participants interpret and respond to highly salient and unconventional stimuli in fictitious decision contexts. As noted, such designs may elicit immediate affective reactions, which could potentially influence choice behavior beyond the intended manipulation. At the same time, pictorial warning are “by nature” salient and unconventional. We have addressed this issue by expanding the discussion of external validity and methodological constraints in the revised manuscript, as follows (see page 22f, 826-840).
 - **“Forth, although pictorial warnings are intended to be salient by design, their implementation in the present study may have been relatively unconventional, as they were not embedded within a broader contextual framing or cover story. This may have introduced additional variance beyond the intended psychological mechanisms of the intervention that was not fully captured by our measures of social desirability. While the unrelated nudge condition (i.e., a dead fish infested by maggots) was suitable from an internal validity perspective, as it provided a clearly distinct comparison condition, it was (as intended) not directly linked to the consumption context (i.e., plastic pollution). However, as a result, it may have been perceived as incongruent within the fictional decision environment, potentially influencing choice behavior beyond the intended manipulation. Future research using different cover stories and alternative control conditions in online settings, as well as field studies and longitudinal designs in real purchasing contexts, would be valuable to further assess the ecological validity of such interventions and to clarify their underlying mechanisms.”**
- Line 919 – 920: I think that future studies should also take positive emotions into account – d also with a view to comparing the effects of induced negative emotions versus positive emotions.
 - Thank you for this suggestion. We added this aspect as future direction as follows (see page 24f., ll. 923-925): **Finally, comparing the effects of pictorial warnings with positive valenced pictorial nudges would clarify when and to what extent pictorial warnings are more suitable and practically viable than positive interventions.**
- Line 961/ referring to practical implications: From a practical standpoint, it’s important to note that – especially when it comes to images that trigger negative emotions – one should naturally keep in mind that these cannot/ should not simply be displayed in real-life settings or on everyday products. Even if regulations similar to those for tobacco products were in place here, a key difference is that tobacco products are explicitly intended only for an adult audience and are or at least should not (be) readily accessible to all customers in supermarkets and similar retail settings. With everyday products, such as beverages, etc., however, the situation is different: Couldn’t this potentially lead to issues regarding the protection of children and adolescents? Of

course, it is not the authors' job to offer a direct solution to this problem. However, I think it is important to at least address this issue.

- Thank you very much for highlighting this important aspect, which we addressed as follows in the practical implications' section: "[...] One practical advantage of pictorial warnings is their simplicity and accessibility. Images can evoke stronger affective reactions than written text alone (De Houwer & Hermans, 1994; Noar et al., 2016) and may reach broader audiences independent of literacy levels or language barriers (Jae & Viswanathan, 2012; Viswanathan et al., 2005). Moreover, prior research suggests that warning effectiveness may depend more strongly on perceived credibility than on the specific source of the message itself (Kranzbühler & Schifferstein, 2023), indicating that pictorial warnings could potentially be implemented by a range of governmental or commercial actors. **At the same time, the use of pictorial warnings raises ethical and practical considerations, particularly regarding their exposure to vulnerable populations such as children and adolescents in everyday retail environments, which may require careful consideration of their appropriate placement.**" (p. 25; ll. 924-945)