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# Rising stars in environmental psychology

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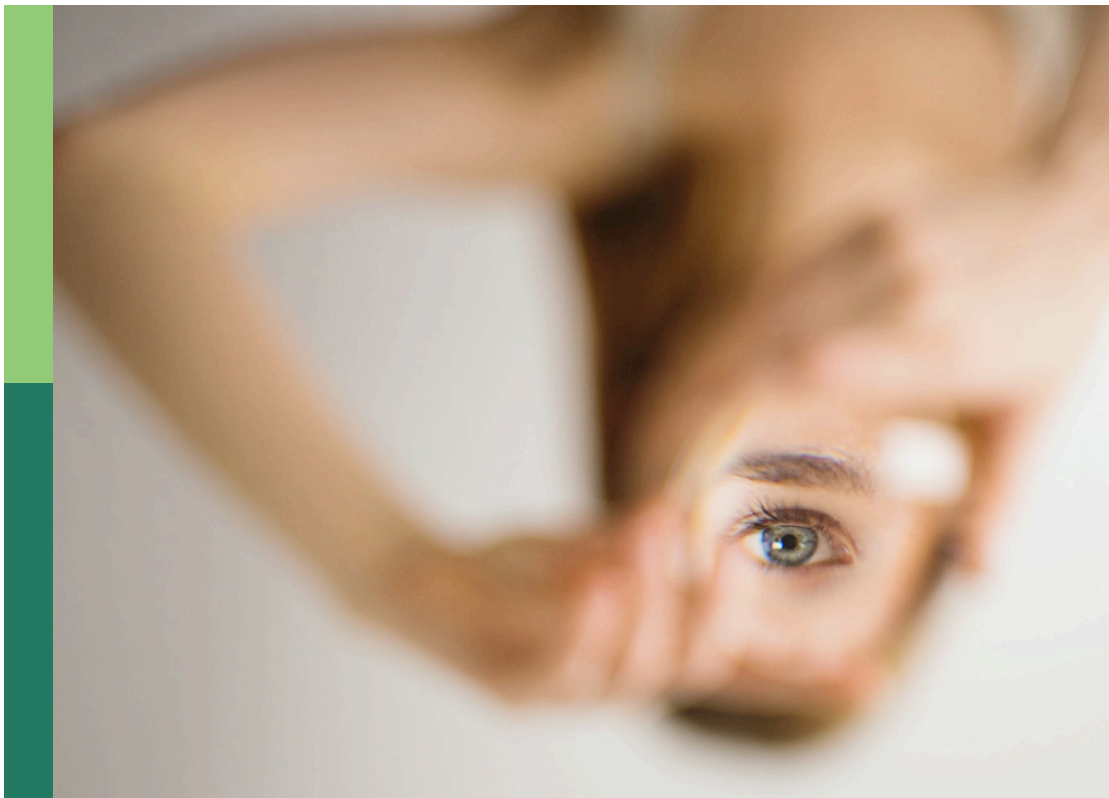

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# Rising stars in: Environmental psychology

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BRIEF RESEARCH REPORT
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# Can We Barter Local Taxes for Maintaining Our Green? A Psychological Perspective

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Previous research highlighted that the desire for neighborhood improvement is an antecedent of the citizens' involvement in green urban areas maintenance. Nevertheless, the topic of civic participation in the maintenance of green areas is not yet well developed in the literature and a link with local legislation is missing. We investigate the intention of participation in such maintenance through a web-based experiment. We hypothesize that stimuli of poor (vs. good) maintenance will be associated with a higher intention of contributing to the upkeep of green areas following the administrative barter law. The administrative barter is a law approved in Italy, which gives citizens the possibility of a reduction of local taxes in exchange for their involvement in the improvement of the territory. One hundred ninety-six participants ($M_{age}$ = 33.81) were assigned randomly to good maintenance condition ($n$ = 100) or poor maintenance condition ($n$ = 96). The level of maintenance was manipulated through photographs of a neighborhood depicting good or poor maintenance of the urban green ornamentation. Results pointed out that people showed a greater willingness to engage in the improvement of green urban areas in the poor condition as compared to the good condition, according to the administrative barter law. This study suggests that local legislation may provide an incentive fostering citizens' involvement in green urban areas maintenance.

**Keywords: urban ecosystem service, urban ecosystem disservice, local law, urban green, green maintenance, civic participation, residents' involvement, neighborhood participation**

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## INTRODUCTION

The cities' landscapes are changing as the awareness of the importance of green in urban areas for people's lives is increasing. The trees of avenues, parks, and gardens, originally created for ornamental purposes, now play an important role in urban life for their ability to enhance individuals' physical health as well as socio-psychological well-being (Tzoulas et al., 2007; van Dillen et al., 2012). Urban greenspace has been associated with greater physical activity and longevity (van Dillen et al., 2012; Rojas-Rueda et al., 2019). Moreover, exposure to natural views has been related to greater psychological well-being with lower stress symptoms and depression, and greater attention (Li and Sullivan, 2016; Braçe et al., 2020). The supportive effect of green views for mental health was particularly evident during Covid-19 lockdowns (Soga et al., 2021). Nevertheless, the benefits are not limited to the individual alone; indeed, the presence of natural elements in the urban ecosystem was found to enhance a sense of community, social relationships among residents, and

even to lower criminality (Kuo and Sullivan, 2001; Donovan and Prestemon, 2012; van Dillen et al., 2012). Finally, benefits for residents pass also through the role of urban forests and trees as Nature-Based Solutions, namely adaptation strategies to many urban environmental problems, such as local cooling, air pollution reduction, and urban stormwater runoff management (Mullaney et al., 2015).

Generally speaking, the importance of green urban spaces is recognized and valued by citizens (Grima et al., 2020). However, studies suggested that one factor that can limit the benefits of such areas is the state of maintenance (von Döhren and Haase, 2015). Poor upkeep can hinder the visit to urban parks and also diminish the willingness to engage in physical activity in green areas (Van Hecke et al., 2018). On the contrary, good maintenance of urban green beautification seems to impact the preference for an area (Kuo et al., 1998). According to the literature, physical aspects of the neighborhood such as esthetics, walkability, and, importantly, state of maintenance are also linked to perceptions of safety and even provide insight into the relationships between area residents (Kuo et al., 1998; Cerin et al., 2006; O'Brien and Wilson, 2011). Individuals use environmental cues adaptively, remaining vigilant in a neighborhood deemed potentially dangerous. They are therefore attentive and read the information that comes from the physical conditions of a neighborhood as they are used to program their behavior (O'Brien and Wilson, 2011; Donovan and Prestemon, 2012). Following this line, well-maintained areas convey a sense of community care, which in turn is supposed to prevent the engagement in criminal behavior (Kuo and Sullivan, 2001).

Overall, we can define maintenance as an urban ecosystem service and poor upkeep as an urban ecosystem disservice (Millennium Ecosystem Assessment, 2005; von Döhren and Haase, 2015). Urban ecosystem services refer to the benefits of natural ecosystems, while urban ecosystem disservices origin from the qualities of the natural environment that are perceived as harmful, unpleasant, or unwanted (Millennium Ecosystem Assessment, 2005; Shapiro and Báldi, 2014; Villa et al., 2014; Lyytimäki, 2015; von Döhren and Haase, 2015). According to some authors, this classification encourages discussion about the social and economic consequences of disservices (Shapiro and Báldi, 2014). Roots coming out of the streets can lead to trips, long branches can cover important traffic signs, undesired wild vegetation can contribute to a loss of esthetics of the landscape as well as instill a sense of insecurity. These are all examples of poor upkeep that can lead to discomforts. Furthermore, when maintenance is procrastinated or even absent, it can lead to damage to the adjacent environment (e.g., tarmac, water pipes), with subsequent need for additional public funding (von Döhren and Haase, 2015).

In sum, green urban spaces are central to the life of urban residents, but they are not always in a good condition to ensure the benefits they can bring to people (von Döhren and Haase, 2015). Therefore, it becomes important to investigate how to support it. Hence, what can be done to sustain maintenance? Research suggests that a key role is played by the involvement of residents (Ohmer et al., 2009). The upkeep of gardens, parks, and green decorations is often sustained by volunteers and neighbors' associations (Wolf et al., 2013). However, in a study, it was found that although citizens report avoiding visiting parks when they feel there had been improper management, only 20% of them would like to be involved in the maintenance (Lee and Kim, 2015). In some countries, local administrations have issued laws that can stimulate civic participation. For instance, the administrative barter is an Italian law that guarantees reduction or exemptions from local taxes to people who want to participate in the maintenance of the urban green areas (Cepiku, 2017). Nevertheless, participation in such initiatives is increasingly diminishing over the years (Istat, 2021, 2018).

It is important to note that engagement and participation result in economic advantage, contributing also to the improvement of governance (Butt et al., 2021). Therefore, the focus should be on the factors that can promote engagement. Previous findings point to the desire for neighborhood improvement as an antecedent of citizens' involvement in green urban areas maintenance (Moskell et al., 2010). In particular, it seems that the perception of a compelling necessity and an urgent intervention is what triggers the willingness to be active participants in the restoration of green spaces and landscape beautification (Wolf et al., 2013). Nevertheless, although there is flourishing literature on the psychological underpinnings of civic participation (Albanesi et al., 2007; Marzana et al., 2012; Francescato et al., 2017), the topic of civic participation specifically concerning the maintenance of green areas is not yet well developed in the literature (Krajter Ostoić and Konijnendijk van den Bosch, 2015). Following this line, the purpose of this study is to investigate the intention of participation in such maintenance, focusing on the perceptions of the qualities of the areas rather than on individuals' characteristics. Accordingly, our study hypothesis is that poor (vs. good) maintenance will be associated with a higher intention of contributing to the upkeep of green areas following the administrative barter law.

# METHODS

## Participants and Procedures

To test our hypothesis, we designed a 2 × 2 between-subjects study collecting data from an online survey. All participants were informed of the voluntary nature of their participation in the study and that they could interrupt the questionnaire at any time. After being assured of anonymity, informed consent was collected from all participants. Data were collected through a Google Form, namely a free Google app for creating surveys, shared through social media and personal contacts. There were no particular recruitment targets: the questionnaire was administered to those who understood the Italian language, without limits of age, qualification, or gender. More specifically, there were two versions of the questionnaire, one for each experimental condition (good vs. poor maintenance of the urban green ornamentation), and participants were assigned randomly to the two conditions. The level of maintenance was manipulated through a slideshow of photographs of an Italian

neighborhood depicting good or poor maintenance of the urban green ornamentation.

In the condition of poor maintenance, the photographs presented real-life situations where the pavement or the asphalt had been damaged by the roots of trees (see **Supplementary Figures 1–4**). On the contrary, in the condition of good maintenance, the photographs were modified with a photo editor software to show the good condition of sidewalks and roads (see **Supplementary Figures 5–8**). Participants were asked to imagine being residents of the neighborhood displayed in the photographs and to answer the questionnaire accordingly. Across the two conditions, the two questionnaires were similar in all aspects except for the presentation of the photographs.

An *a priori* power analysis using the software G*Power (Faul et al., 2007) suggested that a minimum sample size of 169 participants was required to observe, with our study design, an effect size of 0.25 with 90% power at $\alpha = 0.05$. As recommended by Oppenheimer et al. (2009), to detect participants who were not focusing on the questionnaire, we used one question, a so-called attention check: "*This question is to check the attention of the respondent, if you are paying attention please answer 4.*" Participants who did not answer correctly to the attention check were excluded from the analysis. A total of 220 participants agreed to participate in the research, of which 24 failed to answer the attention check. Thus, our final sample was composed of 196 participants, of which 100 (51%) were in the good maintenance condition and 96 (46%) were in the poor maintenance condition.

Of the total sample, 136 (69.38%) were women. Age ranged from 18 to 81 (M: 33.81; SD = 15.56). Regarding marital status, 129 (65%) were single, 37 (18.9%) were married, 25 (12.8%) were living with the partner, 4 (2%) were divorced, and 1 (0.5%) was widowed. Regarding the education qualification, of the total sample, 11 (5.6%) held a junior high school diploma, 95 (48.5%) held a high school diploma, 30 (15.3%) held a bachelor's degree, 49 (25%) held a master's degree, and 11 (5.6%) held a higher degree (e.g., doctoral). Regarding the employment status, 81 (41.3%) were students, 73 (37.2%) were employees, 22 (11.2%) were self-employed, 11 (5.6%) were unemployed, and 9 (4.6%) were pensioners.

## Measures

### Manipulation Checks

To check if our manipulation was successful, namely if, as expected, the two sets of photos were portraying urban green ornaments in good vs. poor maintenance conditions, we used manipulation check measures. Specifically, we asked participants to evaluate different aspects of the neighborhood shown in the photos, namely pedestrian mobility, road practicability, flooring, and esthetics. The responses were ranked on a 5-point scale.

A one-way ANOVA was performed for each of the four aspects with the condition as the independent variable. As expected, results attested that: 1) pedestrian mobility resulted higher in the good ($M = 2.10$, SD = 0.99) vs. poor ($M = 1.36$, SD = 0.71) maintenance condition and the difference was statistically significant $F(1, 194) = 35.38$, $p < 0.001$, $\eta^2_p = 0.15$; road practicability was rated higher in the good ($M = 2.51$, SD = 1.07) vs. poor ($M = 1.84$, SD = 0.94) maintenance condition and the difference was statistically significant $F(1, 194) = 21.13$, $p < 0.001$, $\eta^2_p = 0.10$; flooring was evaluated higher in the good ($M = 1.73$ DS = 0.90) vs. poor ($M = 1.26$, DS = 0.65) maintenance condition and the difference was statistically significant $F(1, 194) = 17.43$, $p < 0.001$, $\eta^2_p = 0.08$; lastly, esthetics was rated higher in the good ($M = 1.67$ DS = 0.94) vs. poor ($M = 1.28$, DS = 0.69) maintenance condition and the difference was statistically significant $F(1, 194) = 10.76$, $p < 0.01$, $\eta^2_p = 0.05$. Overall, the manipulation can be considered successful.

### Willingness to Actively Engage in the Maintenance of the Green Ornamentation of the Neighborhood

After being exposed to the photographs, participants of both conditions were asked to imagine living in the neighborhood shown in the images and answer to a scenario in which they were presented with the possibility to take advantage of the administrative barter law. The administrative barter is a law approved in 2014 in Italy (Law decree n. 164, art. n. 24), which gives citizen or legally recognized associations the possibility of a reduction or exemption of local taxes in exchange for their involvement in the improvement of the territory. We used the following scenario:

In the neighborhood shown in the photos, the law administrative barter is in force (article 24, law 164 of 2014 "Measures to facilitate the participation of local communities in the protection and enhancement of the territory)." According to this law: "Municipalities can define criteria and conditions for the realization of interventions by citizens to enhance the urban or extra-urban territory, such as cleaning, maintenance, embellishment of green areas, squares, streets, or interventions of urban decoration, recovery, and reuse, to act in the general interest, in support of areas and unused real estate. To this end, the local authority may approve the granting of a reduction or exemption of local taxes relating to the activities carried out by the aforementioned subjects."

After the scenario, participants were asked to answer the following question: *"Based on this law, would you contribute to the adequate maintenance of your neighborhood?"* The possible answers were "Yes" or "No."

## Statistical Analysis

The data analysis consisted in the analysis of the frequencies of dichotomic responses (yes or no) to the question on the willingness to actively engage in the maintenance of the green ornamentation of the neighborhood. To test the hypothesis that participants in the condition of poor (vs. good) maintenance would report a greater willingness to actively engage in the improvement of green ornaments according to the administrative barter, we proceeded to test whether the proportion of yes and no answers was different by condition (i.e., poor and good maintenance). To do so, we performed the chi-square test for independent samples. This test allows us to compare the "expected" results with those observed in our data. By expected results, in this case, we mean that the yes and no answers that indicate the tendency or not to actively engage in the

improvement of green ornaments are distributed in a similar way among both conditions (i.e., poor and good maintenance). In other words, that the yes and no answers are independent of the condition. The higher the chi-square value, the more the observed distribution will differ from that expected. In other words, a high (and significant) chi-squared value will indicate that in the two conditions the proportions of yes and no answers are distributed differently by condition, namely that the two variables are dependent on each other.

## RESULTS

Results attested that the chi-square was significant $\chi^2 = (1, 196) = 4.12$, $p < 0.05$, suggesting that there was a significant difference between the observed frequency of yes and no responses and the expected one for the two conditions. **Table 1** is a contingency table where the yes and no answers are reported by condition: as can be seen, in the condition of poor maintenance we have a greater willingness to actively engage in the improvement of urban green ornaments according to the law of administrative barter as compared to the condition of good maintenance.

## DISCUSSION

The added value of urban greenspace to residents' lives can be endangered when the areas are not accurately maintained, causing a disservice (von Döhren and Haase, 2015). In this contribution, we wanted to shed light on the motivational mechanisms behind the willingness of the residents to participate in the maintenance of urban greenery in line with the administrative barter law. This regulation establishes that citizens voluntarily engage in the upkeep of their neighborhood in exchange for a deduction in the taxes. To do so, we designed a study in which participants were asked to imagine living in a neighborhood with good vs. poor maintenance of urban green spaces and then indicate whether they would engage in the maintenance following the administrative barter law. Findings revealed that poor upkeep resulted in a higher willingness to participate in the maintenance than good upkeep. These results confirmed our hypothesis.

This study is not free of limitations. First, since data were collected online, results need to be replicated in a more controlled environment such as the laboratory. Second, we captured intentions (a measure sensitive, for instance, to social desirability) and not actual behavior, using a single-item measure. Thus, future studies should replicate findings in the laboratory to directly observe behavior or develop scales to measure intentions. Third, we used a snowball sampling technique that does not always guarantee that individuals in the two groups can be comparable. Fourth, almost half of the participants were students; thus, the generalizability of the findings is limited. Fifth, we used stimuli that focused on the disservices of mostly ornamental trees included in the urban landscape also to implement adaptation strategies to climate change. It will be interesting if future studies could extend the materials presented including images from urban parks. Lastly, we asked participants to imagine being residents of the neighborhood in the pictures. We believe that further studies could examine more closely the intentions of individuals toward their neighborhood since in this relationship other variables could intervene (e.g., place attachment and identity, sense of community).

All in all, our findings are in line with past literature that identified the necessity for maintenance as an important trigger of individuals' motivation (Moskell et al., 2010; Wolf et al., 2013). Nevertheless, we believe that this research makes a step further. Specifically, it presents innovative aspects that deserve consideration. First, the psychological literature on this specific type of voluntary action is scarce (Moskell et al., 2010). Second, to our knowledge, this is the first psychological study to investigate the willingness to adhere to the administrative barter law. In particular, our study suggests that taxes reduction or exemptions, together with the awareness of poor maintenance, can represent a good incentive that can encourage participation in maintenance. From here, future studies could examine the role of additional variables that could intervene in the relationship observed. For instance, collective efficacy has been proved to play a role in previous studies investigating the willingness to ameliorate one's neighborhood (Rice et al., 2016). Moreover, motivation can be investigated in line with the literature on voluntarism (Moskell et al., 2010). First, individual differences could explain the participative behavior such as the prosocial personality, psychological empowerment, and political self-efficacy (Penner, 2002; Caprara et al., 2009; Christens et al., 2011). Second, also previous experiences in such types of collective participation can play a role in preventing or stimulating engagement (Moskell et al., 2010).

We believe that this study's findings offer important practical implications for policymakers. In particular, they point to knowledge and awareness of the state of maintenance as a catalyst of residents' involvement (Butt et al., 2021). This means that working on enhancing awareness of the poor maintenance and its consequences for the population could promote intentions to change the situation. Apart from the immediate benefits of treating a disservice, it is important to note that involvement in ameliorating one's community might result also in positive outcomes for residents such as strengthened social relationships with neighbors and an enhanced sense of community and place attachment (Moskell et al., 2010; Stewart et al., 2019).

**TABLE 1 |** Contingency table reporting Yes or No responses to the scenario proposing the administrative barter.

| | Willingness to actively engage in the improvement of urban green ornaments | | |
|---|---|---|---|
| | **No** | **Yes** | **Total** |
| Good maintenance | 21 | 79 | 100 |
| Poor maintenance | 10 | 86 | 96 |
| Total | 31 | 165 | 196 |

Lastly, is important to highlight that, apart from the positive implications of the administrative barter law, some authors expressed a few criticisms. The most relevant to our discussion is, in our opinion, the one that considers the exchange proposed by the law as commodification of the right to participate in the maintenance of a collective good as the urban green. In particular, the advocates of such perspective maintain that being more appealing to the disadvantaged citizens, the administrative barter law can be viewed more as an obligation than a free choice, creating dependence and subordination rather than motivating citizens (Giglioni, 2015). Translated in psychological terms, this law would create extrinsic motivation whereas what seems central is how to stimulate intrinsic motivation in residents. We think that working toward a better awareness of both the state of maintenance of green areas and the sociopsychological advantages of civic participation could pave the way to the intrinsic motivation of residents. Another criticism revolves around the issue of political responsibility of the upkeep of public areas and the instrumental use of citizens in the administrative barter law (Giglioni, 2015). Beliefs on political responsibility should be considered, as well as residents' trust in political institutions. Both variables could play a role in the willingness to engage in the maintenance of green areas following the administrative barter law and, thus, their role should be investigated in future studies.

In conclusion, the implementation of urban forestry and greenery is not always feasible for several reasons (e.g., lack of space); however, when it is included in the city planning, management and upkeep of these areas become vital. It has been proposed that the concept of ecosystem disservice can facilitate the dialog between social sciences (e.g., with the topic of civic participation in the maintenance of green areas) and natural sciences (Lyytimäki et al., 2008). We agree with this conceptualization and focus, in our research, on the contribution of social-environmental psychology to assess what can be done for transforming a malfunction in benefits for individuals. Our study suggests that this can be achieved through combined forces of local administrations and common citizens.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

AT and AP contributed to the conception and design of the study. MA and EM contributed to the study materials. AT wrote the first draft of the manuscript, organized the database, and performed the statistical analysis. AP, MA, and EM contributed to the manuscript revision. AP, MA, and GC were the project administrators and acquired the necessary fundings. All authors read and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.816217/full#supplementary-material

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# Potential Contributions of Behavior Analysis to Research on Pro-environmental Behavior

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Large parts of contemporary research on pro-environmental behavior focus on mechanistic explanations and mental constructs. Exclusive reliance on this approach may hinder the search for novel solutions to conceptual problems, more powerful methods, and innovative behavior change interventions. Theoretical diversity, on the other hand, can render a field adaptive in its responses to crises and impasses. Against this background, we describe the complementary approach of behavior analysis and its potential contributions to problems of contemporary research on pro-environmental behavior. Behavior analysis (1) provides a consistent account of phenomena that are difficult to reconcile with the mechanistic perspective, (2) redirects the spotlight to context, (3) provides a framework and methodology for assessing behavior with actual environmental impact, and (4) could inspire the development of new intervention techniques. Based on these contributions, we conclude that behavior analysis could substantially enrich research on pro-environmental behavior.

**Keywords: pro-environmental behavior, behavior analysis, context, consequences, intervention, measuring behavior**

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## INTRODUCTION

Theoretical approaches guide the work of behavioral scientists (Glanz et al., 2008; van Lange, 2013). This guidance is necessarily selective: it favors some explanations, methods, and interventions at the cost of others (Crosby et al., 2002). Exclusive reliance on one theoretical approach may limit the success of a field. Theoretical diversity, on the other hand, can render a field adaptive in its responses to crises and impasses. As behavioral scientists interested in the study of pro-environmental behavior, we believe that our field could benefit from broadening its theoretical focus in its search for novel ways to address environmental issues.

In particular, we perceive contemporary research on pro-environmental behavior to be dominated by a focus on mechanistic, "social psychology-based theories" (Gifford et al., 2011, p. 442). Within this approach, researchers primarily study the role of mental states and mechanisms that are assumed to cause pro-environmental behavior. In this article, we do not wish to question the contributions of this approach, but rather highlight the contributions of an alternative approach with complementary strengths: behavior analysis.

## PRINCIPLES OF BEHAVIOR ANALYSIS

Behavior analysis is a natural-science approach to understanding the behavior of individuals (APA Div. 25: Behavior Analysis, 2013; Pierce and Cheney, 2017). This means that behavior is studied as a function of natural (rather than immaterial, mental) events and processes (The Association for Behavior Analysis International, 2020). By this means, behavior analysts seek to discover the principles that guide behavior and to apply these principles to solve behavioral problems.

Based on the work of Skinner (1953, 1974), behavior analysis is characterized by a focus on *contingencies* (i.e., the relationships between environment, behavior, and its consequences) as a key concept in behavioral explanation. It proceeds from the observation that behavior, in interaction with the environment, produces consequences in the physical world. For example, cycling to work on a rainy day may produce the consequence of being soaked and wearing a fur coat at an animal welfare rally may produce the consequence of raised eyebrows. Contingencies are assumed to select the behavior of individuals and it is this selection which is the central mode of causation in behavior analysis. Notably, it parallels the mode of causation in natural selection (Skinner, 1981, see also Glenn, 1988; McDowell, 2004, 2019; Baum, 2017; see Borgstede and Eggert, 2021 for a unified account), but in contrast to natural selection, selection does not occur across generations, but across situations within the lifetime of the individual (i.e., ontogenetically, see **Figure 1** for an example).

The empirical program of behavior analysis reaches from laboratory experiments with non-human animals to field studies in societally relevant contexts. The experimental analysis of behavior, on the one hand, is concerned with examining the effects of systematically manipulated contingencies under controlled circumstances. The data obtained from this analysis are then inductively integrated into principles of behavior. Applied behavior analysts, on the other hand, make use of the principles discovered in the experimental analysis of behavior to address behavioral problems in less controlled circumstances. For example, they may account for pro-environmental behavior by referring to principles of operant conditioning, delay-discounting or generalization (Lemos et al., 2019; Schneider and Sanguinetti, 2021; Wille, 2021). Based on a functional analysis of the contingencies that maintain a behavior, applied behavior analysts aim to rearrange contingencies to promote alternative behaviors. The effect of these rearrangements is typically studied longitudinally, for example, through introducing, removing, and reintroducing an intervention (Bailey and Burch, 2018). By this means, it is possible to demonstrate that a target behavior (e.g., gasoline consumption) of a target population (e.g., car drivers in Texas during the oil crisis) varies as a function of the intervention (e.g., presenting feedback about gasoline consumption on the evening news; Rothstein, 1980).

With its focus on contingencies and experimentation, behavior analysis invites questioning of existing societal incentive structures. This is nicely illustrated in *Walden Two*, a novel written shortly after World War II (Skinner, 1948). In Walden Two, Skinner describes an egalitarian community of close to a thousand members who are encouraged "to view every habit and custom with an eye to possible improvement" (1948, p. 25). Practices, policies, and community structures are subject to continuous experimentation and selected based on evidence rather than dogmatism. From this approach, context changes emerge that are found to promote the sustainability of the community and the well-being of its members. These experimental practices reflect Skinner's intention to present Walden Two as an illustration of how behavior analysis can contribute to a sufficiency-oriented alternative to consumerism (and the associated environmental pollution; Skinner, 1976). Issues of environmental sustainability are treated to an extent that may be considered atypical for the 1940s (Altus and Morris, 2009). Members of Walden Two build energy-efficient buildings, practice sustainable agriculture, reduce food waste, and share their facilities and devices. Nine-to-five routines are replaced with flexible, staggered schedules that allow making more efficient use of space and equipment (and to reduce crowds) and unnecessary possessions are largely avoided.

Of note, the experimental approach of Walden Two (and applied behavior analysis in general) bears close resemblance to contemporary concepts of real-world laboratories and living labs (Schäpke et al., 2018; Wanner et al., 2018), suggesting that behavior analysis may inform the search for behavioral sustainability solutions. Important tenets of behavior analysis, such as the theory of reinforcement learning, have already been incorporated successfully into other fields such as neuroscience (e.g., Schaal, 2013), behavioral economics (e.g., Rachlin et al., 1976) or neuroeconomics (e.g., Sawe and Chawala, 2021). Here we would like to specifically point to the potentials of behavior analysis that we see for the field of environmental psychology.

## DIFFERENCES FROM MECHANISTIC APPROACHES TO STUDYING PRO-ENVIRONMENTAL BEHAVIOR

While the current theoretical landscape in pro-environmental behavior research is far from homogenous (Vining and Ebreo, 2002; Steg and Vlek, 2009; Kaiser et al., 2010; Bamberg, 2013; Klöckner, 2013; Gifford, 2014), it appears that most contemporary attempts to explain pro-environmental behavior do so by referring to mental constructs (e.g., attitudes, intentions, beliefs, goals). Such constructs, internal to the individual, are seen as proximate, *mechanistic* causes of behavior. Behavior analysis employs a different mode of causation for the explanation of behavior. Behavior analysts seek to describe orderly relationships between context, behavior and its consequences, and they refer to these *functional* relationships to explain how a behavior has been selected over the lifetime of an organism (see also Skinner, 1985; Hineline, 1990; Todd and Morris, 1992; Chiesa, 1994; Moore, 1996; Moore, 2003; Leigland, 2010). In doing so, they do not deny the existence of mechanistic causes or mental constructs, they are simply interested in another type

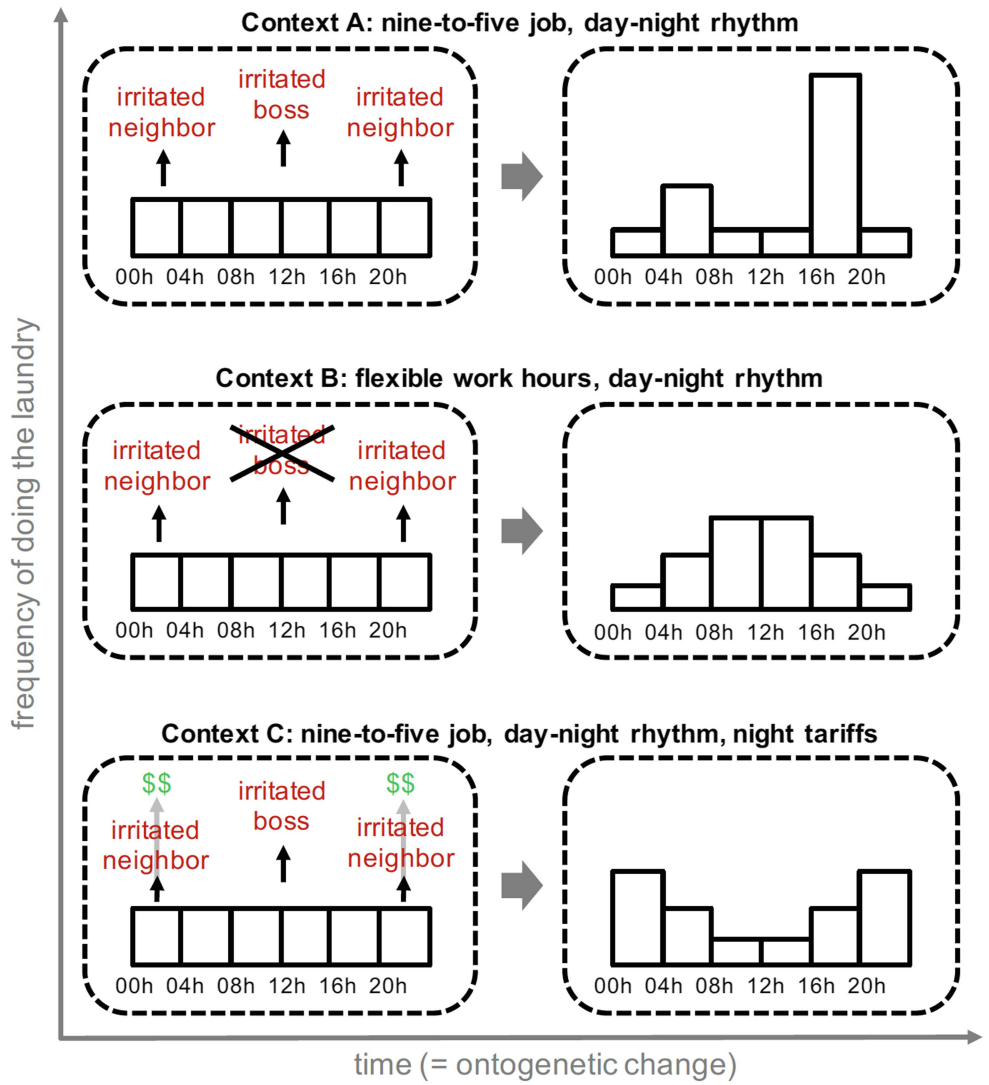


**FIGURE 1 |** Example of ontogenetic selection for doing laundry in three different contexts. Energy using behaviors (e.g., doing laundry) produce different consequences when performed at different times of the day. Critically, these consequences depend on the context of energy using behavior (e.g., the working hours of the individual; Wille, 2021). Context-dependent consequences select the behavior and, as a result, the distribution of energy using behavior changes over time (i.e., it adapts to the context; Wille, 2021). In some contexts (e.g., Context A), this may lead to an environmentally disadvantageous behavior distribution (i.e., evening peaks of household energy consumption when energy supply from renewable sources tend to be low). In order to approach such environmental issues, the perspective of behavior analysis suggests to modify the context in a way that behavior produces different consequences (i.e., to rearrange contingencies), so that the ontogenetic development of behavior can take a different direction. In Context B, for example, a context change (i.e., the flexibilization of work hours) entails that doing the laundry at noon does not lead to negative professional consequences (e.g., falling from favor with your employer, loss of earnings). With one of the main reasons for the evening peak in energy consumption being removed, behavior may become more evenly distributed across the day. Similarly, Context C involves a differential tariff structure that rewards doing the laundry at night. Implementation of such tariff structures can change how energy using behavior is selected and thus distributed across the day. It is noteworthy however that such tariff structures are unlikely to be as effective as suggested in this figure because of the dominating influence of other elements of the existing context (e.g., inflexible working hours; Wille, 2021).

of explanation (i.e., in another one of Tinbergen's four questions; Tinbergen, 1963).

As a corollary, behavior analysis and mechanistic approaches differ in the role and importance they assign to context factors in explaining behavior (**Figure 2**). Behavior analysts consider contextual characteristics to be relevant to the degree to which they determine the consequences of behavior, whereas in mechanistic approaches, context factors are considered relevant if they affect mental mechanisms. When trying to explain pro-environmental behavior, researchers working within mechanistic approaches would rather focus on identifying mental constructs that explain a meaningful amount of variance in that behavior. Behavior analysts, by contrast, would aim to identify contextual contingencies that

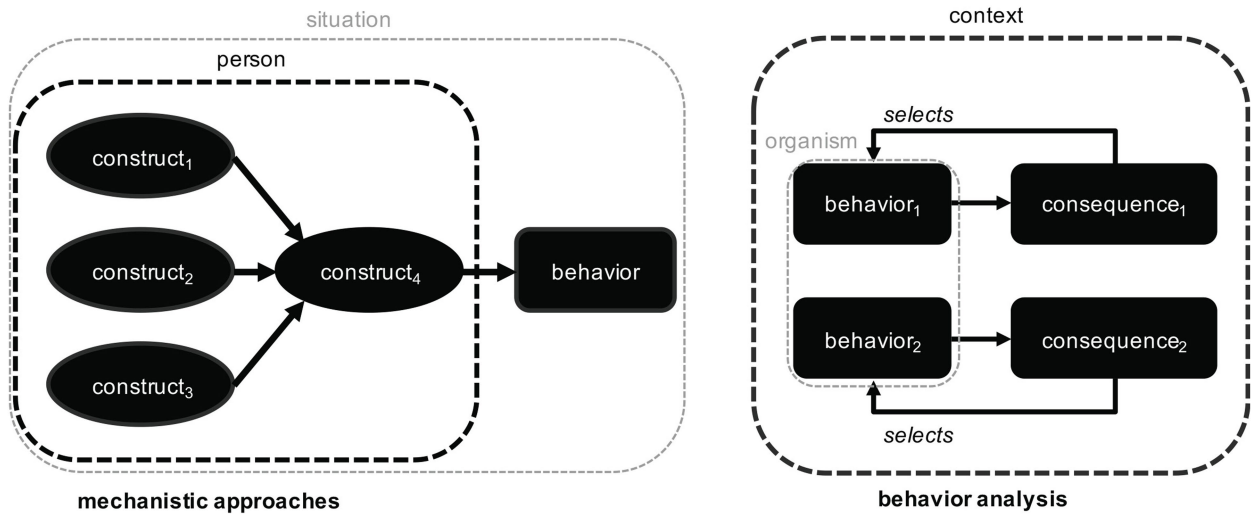


**FIGURE 2 |** Comparison between mechanistic approaches and behavior analysis. Mechanistic approaches to explaining pro-environmental behavior (on the left, with a focus on mental processes within an individual) is contrasted with behavior analysis (on the right, with a focus on behavior-consequence relationships in context).

maintain or alter the behavior in question. They might also take into account potential interrelations between different behaviors. For example, a behavior analysis account of participating in pro-environmental demonstrations might not only refer to the consequences that accompany participation, but also to the consequences that maintain other behaviors (e.g., going to the gym) when they conflict with participation.

These theoretical differences also affect the type of methodology researchers use when studying pro-environmental behavior. On the one hand, the focus on mental constructs relates to the development of assessment tools (e.g., self-report scales) that are assumed to provide information about those constructs. These tools are then used to study the relationship between mental constructs and pro-environmental behavior, often in correlational survey studies. On the other hand, the focus of behavior analysis on behavior in its own right comes with an emphasis on field observational and experimental studies that examine behavior as a function of changing environmental contingencies.

## DISCUSSION: POTENTIAL CONTRIBUTIONS TO RESEARCH ON PRO-ENVIRONMENTAL BEHAVIOR

In our view, the abovementioned theoretical and methodological differences point to the great potential of embracing behavior analysis as a complementary approach to studying pro-environmental behavior. With its focus on determinants and explanations that receive less attention within mechanistic approaches, behavior analysis can enrich the search for behavioral solutions to sustainability problems. This is neither speculation nor a new idea. In fact, behavior analysis has a longstanding tradition in applying its principles to the study and promotion of pro-environmental behavior research (Cone and Hayes, 1980; Dwyer et al., 1993; Lehman and Geller, 2004; Foxall et al., 2006; Gelino et al., 2021; Schneider and Sanguinetti, 2021). However, only few behavior analysts currently work in the field of environmental psychology (Schneider and Sanguinetti, 2021). As a consequence, we suspect that many environmental psychologists might be unaware of the potential contributions of behavior analysis to the study of pro-environmental behavior.

### Behavior Analysis Could Help Resolve Inconsistencies of Pro-environmental Behavior Research

A different theoretical perspective can shed new light on longstanding problems within a dominant scientific paradigm. One such problem within mechanistic approaches to explaining (pro-environmental) behavior is the so-called attitude-behavior gap (LaPiere, 1934; Kollmuss and Agyeman, 2002; Glasman and Albarracín, 2006; see Carrus et al., 2021, for a recent meta-analysis in the domain of energy saving). Observed inconsistency between pro-environmental behavior and attitudes towards this behavior (as assessed *via* verbal statements) may seem puzzling when the former is assumed to causally depend on the latter. As a consequence, numerous attempts have been made to address this inconsistency within mechanistic approaches. In contrast, this inconsistency appears unproblematic and irrelevant from a behavior analysis perspective. Behavior analysts would not expect two different behaviors such as verbal attitudinal statements and overt pro-environmental behavior to converge

(see also DeFleur and Westie, 1963). In most cases, such behaviors can be expected to diverge because they are the result of different selecting contingencies. For example, verbal statements about buying environmentally friendly laundry detergents may be a function of consequences such as positive verbal affirmations of peers, while picking up a laundry detergent from the supermarket shelf might be a function of consequences such as a higher monetary loss in comparison to another laundry detergent.

This example illustrates how a different theoretical perspective such as behavior analysis could help identify conceptual impasses and refocus research priorities. Instead of investing a lot of resources closing a putatively problematic attitude-behavior gap, behavior analysts would separately study the determinants of overt pro-environmental behavior and the determinants of verbal behavior about the attitude object. Both behaviors can be of theoretical or practical importance, but they need not be the same or causally linked to each other.

## Behavior Analysis Could Promote the Study of Context

If context factors are selected for scientific analysis primarily based on their assumed relevance for mental constructs and mechanistic explanations of pro-environmental behavior, important contextual determinants may be overlooked (see also Nielsen et al., 2021). With its theoretical focus on functional relationships and contingencies, behavior analysis may promote a more comprehensive and systematic selection and study of contextual determinants. To explain a behavior, behavior analysts examine how the behavior modifies the context and what consequences this context modification has on the behavior of the individual. They would observe, for example, that a student's social context undergoes considerable changes after the student has switched to a vegetarian diet. The student might spend more time with some people and less time with others, receive encouragement from some friends and skeptical comments from others. In turn, these consequences might affect the student's behavior. The student might give up on dairy products as well, return to eating meat, or develop variations in eating behavior dependent on the context of the meal. Functional context-behavior relationships of that kind are described within the framework of behavior analysis and they can offer a powerful means to clarify the effects of contextual factors on pro-environmental behavior.

Thinking about contextual factors in terms of the consequences they produce is likely to enlarge the set of factors that researchers explore as potential determinants of pro-environmental behavior. It may also generate more practically relevant insights on how the environment needs to be designed to facilitate pro-environmental behavior. While correlations between pro-environmental behavior and its perceived difficulty (e.g., Fujii, 2006) do not tell us how perceived difficulty (and thus behavior) can be changed, finding the rate of recycling behavior to vary as a function of the independently manipulated distance to recycling facilities (O'Connor et al., 2010) provides directly applicable behavior-change knowledge.

## Behavior Analysis Could Promote the Measurement of Actual Behavior

Most studies in contemporary pro-environmental behavior research rely on self-report measures (Lange et al., 2018) that face a variety of validity problems (Gifford, 2014; Kormos and Gifford, 2014; Lange and Dewitte, 2019; see also Hausman, 2012, for a related perspective from environmental economics). From a behavior analysis perspective, it does not make much sense to measure actual engagement in pro-environmental behavior by asking participants how they typically behave or how they would behave in a hypothetical scenario. Just as attitudinal statements, such verbal behaviors are often selected by other consequences than actual pro-environmental behavior. In consequence, applied behavior analysts have developed an alternative assessment tradition. They have relied on objective observations of actual behavior in the field, which has resulted in a rich research literature that can be informative for pro-environmental behavior researchers independent of their theoretical background. In addition to instructive analyses of methodological and conceptual aspects of behavioral assessment (Kazdin, 1979, 1982; Nelson and Hayes, 1979; Bailey and Burch, 2018), this literature contains numerous empirical examples illustrating how pro-environmental behaviors can be studied without self-reports (see Lehman and Geller, 2004; Gelino et al., 2021; for review). For example, Mayer and Geller (1982–1983) report a study involving the unobtrusive observation of cycling behavior as a function of an incentive intervention. Similarly, Geller et al. (1973) installed observers in the checkout area of a supermarket to record whether customers bought returnable versus single-use drink containers.

When it is not possible to observe behavior directly or to do so in an unobtrusive way, behavior analysts have observed the products of pro-environmental behavior. An example of this approach is provided by Foxx and Hake (1977) and Hake and Zane (1981) who recorded participants' odometers to calculate the distance traveled by car. Along similar lines, Winett and Nietzel (1975) relied on trained undergraduate students to obtain objective readings from participants' electricity meters and Keller (1991) has counted the number of households that placed recycling bins on the sidewalks of experimental versus control roads.

Sometimes, it might also prove beneficial to artificially arrange situations in a way that promotes experimental validity (Kazdin, 1979). For example, by actively distributing handbills in a grocery shop, Geller et al. (1977) ensured that all customers had similar opportunities to perform the behavior of interest (i.e., littering). This approach of observing behavior in contrived situations may be particularly helpful when baseline frequencies of a pro-environmental behavior are low. A special case of such contrived situations can be found in the laboratory where experimenters can

exert more control over the behavior of interest. Consequential laboratory tasks have been used to study, for example, the effect of feedback (Camargo and Haydu, 2016) or contextual manipulations (Lange et al., 2020) on pro-environmental behavior. Such tasks may also help to integrate research in behavior analysis, environmental psychology, and experimental economics (Berger and Wyss, 2021).

### Behavior Analysis Could Promote the Development of (Novel) Intervention Approaches

The theoretical framework used to explain pro-environmental behavior also constrains the search for effective behavior change techniques. While researchers within a mechanistic tradition predominantly focus on intervention approaches that may alter mental constructs, behavior analysts rather target behavioral contingencies (an approach related to the concept of nudging, e.g., Tagliabue and Sandaker, 2019). Popular intervention techniques such as feedback, use of discriminative stimuli, self-monitoring, and modeling of pro-environmental behavior involve the highlighting of natural contingencies (Winett et al., 1979, 1982). In addition, behavior analysts have examined possible ways to modify contingencies. For example, participants have received cash payments contingent on reductions of their car driving activities (Hake and Zane, 1981) or electricity consumption (Winett and Nietzel, 1975). A recent meta-analysis has found such reward-based interventions to be generally effective, both during the intervention and after reward removal (Maki et al., 2016).

Critically, behavior analysis can offer more than the notion of a general reward effect (Schneider and Sanguinetti, 2021) or the mere idea of studying situational effects. For example, extensive research in the experimental analysis of behavior has focused on the effects of different reward characteristics and contingencies (Ferster and Skinner, 1957). Rewards have been found to produce more stable rates of behavior when they are given only occasionally (rather than after every performance of the desired behavior; Jenkins and Stanley, 1950). Moreover, the stability of behavior change has been shown to increase with increasing behavioral demands to be satisfied before rewards are given (Boren, 1961; Hearst, 1961). Such findings should be particularly interesting for applied pro-environmental behavior research as they indicate that more desired behavior change could be obtained with fewer rewards (thus requiring smaller financial investments; Cone and Hayes, 1980; Schneider and Sanguinetti, 2021). However, a systematic analysis of reward schedules, rates, sizes, and types in the domain of pro-environmental behavior is still lacking. Many principles and functional relations identified in the experimental analysis of behavior have been overlooked in pro-environmental behavior research (Schneider and Sanguinetti, 2021) and may contribute to the development of more (cost-)effective interventions to promote pro-environmental behavior.

## CRITICAL REFLECTION AND CONCLUSION

With its focus on different modes of explanation, different determinants of behavior, and different methodological approaches, behavior analysis can substantially enrich research on pro-environmental behavior. Behavior analysis can help redirect the focus from mental constructs to behaviors of actual environmental relevance and promote the systematic analysis of the context factors determining pro-environmental behavior. It can offer new (or neglected) concepts for changing behavior (e.g., schedules of reinforcement), powerful methods to investigate the effectiveness of interventions (e.g., paradigms for observing actual behavior), and inspiration for the societal transformation towards sustainability (e.g., Walden Two). Of course, these contributions do not uniquely follow from behavior analysis nor are they exclusively realized within behavior analysis. Researchers from other backgrounds also study actual pro-environmental behavior as a function of situational variations and altered contingencies (see, e.g., Osbaldiston and Schott, 2012; McKenzie-Mohr and Schultz, 2014; Karlin et al., 2015; Byerly et al., 2018; Grilli and Curtis, 2021; for reviews) and we do not wish to imply that environmental psychologists would need to convert to behavior analysis in order to do meaningful research. However, we do think that behavior analysis offers a consistent theory, rich research tradition, and source of inspiration that can serve to inform and further improve contemporary pro-environmental behavior research. As such, we believe that assigning a more prominent role to behavior analysis can promote the success of the field and the search for behavioral solutions to environmental issues.

Despite this potential, we acknowledge that many researchers in the field may be hesitant to draw from a perspective that has been criticized as heavily as behavior analysis and its philosophical foundation (i.e., Skinner's radical behaviorism). Some of the most common concerns against Skinner's radical behaviorism are that it would (1) ignore internal constructs such as consciousness and feelings (2) neglect biological and genetic differences and argue that all behavior is acquired during the lifetime of an individual (3) ignore cognitive processes (4) have no place for intention or purpose (5) have a simplistic view on language and (6) be unable to explain complex behavior (Skinner, 1974; Todd and Morris, 1983). Of note, all these points have been identified as misconceptions, they have been addressed and clarified multiple times, but nonetheless remain part of scientific debate, educational textbooks and university students' perceptions (e.g., Skinner, 1974; Bijou, 1979; Todd and Morris, 1983, 1992; Morris, 1985; Lamal, 1995; Adelman, 2007; Arntzen et al., 2010; Racine, 2021). We hope that by presenting important behavior analysis principles in the section Principles of Behavior Analysis, we were able to disperse reservations as long as they belong to the realm of misconceptions.

In contrast, the costs of research in behavior analysis may be considered a true limitation of the approach. Observing actual behavior as a function of actual contextual

changes is necessarily more expensive and time-demanding than research relying on self-report questionnaires and hypothetical scenarios. However, we believe that the benefits of this approach in terms of scientific utility and validity can be argued to justify these costs. In addition, behavior analysis (just as mechanistic approaches) does not offer a fully comprehensive explanation of behavior on all levels of analysis. Focusing on functional relationships and ontogenetic selection, behavior analysis remains silent for example about the precise intraindividual physiological mechanisms that give rise to a particular behavior in a particular moment. A fully comprehensive explanation of behavior will require integration of functional and mechanistic accounts. Such integration is a difficult endeavor [see Hineline (1990); Hughes et al. (2016) for discussion] and beyond the scope of this introductory perspective article. We hope that by presenting the functional approach of behavior analysis here, we can contribute to this integration and further discussions of its complementary merits and limitations.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication. Both authors have contributed equally to this work.

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# Pleistocene Hypothesis – Moving Savanna Perceptual Preference Hypothesis Beyond Savanna

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We provide an extension of the Savanna perceptual preference hypothesis ("Savanna Hypothesis"), supposing that interaction with landscapes offering survival advantage for human groups during evolution might have gradually evolved to permanent landscape preferences. This additional support is based on the palaeoenvironmental analysis of the spread of modern humans into Europe in the late Pleistocene and their living environments there. Our hypothesis is that the preference for park-like landscapes after African savannas experienced a kind of "refreshment" in the Pleistocene. Thus, preferences for certain types of natural settings and scenes may have a more continuous evolutionary history than previously thought. The extended Savanna Hypothesis termed "Pleistocene Hypothesis" might stimulate further work on this important topic linking human evolution and human environmental preferences.

**Keywords: savanna hypothesis, landscape preferences, human health-environment relationships, paleoanthropology, therapeutic landscapes**

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## INTRODUCTION

In this paper, we provide an extension of the perceptual Savanna Hypothesis supposing that human interaction with landscapes offering survival advantage during evolution might have gradually developed into enduring patterns to prefer certain landscapes. This additional support is based on the palaeoenvironmental analysis of the spread of modern humans into Europe and their living environments there. Different factors play a role in this process (Klein, 2008). The role of climate forcing is one of them (e.g., Müller et al., 2011; Staubwasser et al., 2018). Another aspect is the innovation dynamic (Shennan, 2001; Richerson et al., 2009), i.e., the acquired unique abilities to colonize new environments (Hoffecker, 2009). The spread of early hominids can, however, also be explained by the acquisition of food, being essential for the development of the brain as the dispersal of early hominids is correlated to the historical migration of the African buffalo (van Ginneken et al., 2017; van Ginneken, 2019). In this context, theories on the evolution of the human brain should further discuss the current way of landscape perception in relation to that of the hominids (Chin et al., 2022).

But finally, when modern humans arrived in a new area what preferences did they have to answer the question: should I stay or should I go (further)?

The savanna hypothesis was originally formulated as an answer to why humans are bipedal. Thus, it places the agents of selection for bipedality on open grasslands, resulting from the transition of the human ancestors from an arboreal lifestyle to one on the savannas in response to the opening of the African landscape during long-term aridification of the continent (Richmond et al., 2001).

The second aspect of this hypothesis focuses on the psychological processes assuming that due to the long-term hominization in the East African savanna, such environments are part of general landscape preferences of humans. The basic claim of the Savanna Hypothesis is that humans have innate, even automatic tendencies toward preferring certain types of natural settings that provide food, water, and security for survival (Ulrich, 1993). Ulrich (1983) has presented an integrated theory of esthetic and affective response to the natural environment assuming that landscape preferences can be defined as "the first level of reaction to the environment of generalized affect, such as liking or interest" simultaneous with or followed by approach-avoidance behavior (Ulrich, 1983, p. 90). These affective reactions to natural scenes are adaptive and foster well-being in terms of the total behavior of the individual. The initial affective reaction is elicited quickly by certain general properties or preferenda of the view, including gross structural aspects of settings, (e.g., focality, deflected vistas), gross depth properties that require little inference (spaciousness, ground surface texture conducive to movement) and general classes of environmental content, such as vegetation and water. Thus, in this theory, preferences are linked *via* preferenda to survival and well-being. Evolutionary psychology argues that many psychological mechanisms, such as preferences and emotions and behavioral strategies, are solutions to the adaptive problems our species has faced in natural evolution (Buss, 1995). We believe that the scientific basis of a widespread Savanna hypothesis requires further study and we focus on theoretical research of evolutionary biology theories.

## FEAR AND PREFERENCE, SAVANNA HYPOTHESIS AND PROSPECT REFUGE THEORY

For the longest time in human history our ancestors lived in hunter–gatherer bands, thus being intimately connected to other living organisms (Wilson, 1984). Automatic reactions of fear and escape after the detection of predators were important agents of selection on ancestral humans (Öhman and Mineka, 2001). Many studies stress the evolutionary origins of human fear of some animals and show evidence that people detect the presence of fear-relevant animals (i.e., snake, spider) faster than the presence of a pleasant stimulus (i.e., flower, mushroom) (Öhman et al., 2001; Lipp et al., 2004). Even preschool children share this special attention to snakes and detect them faster than other stimuli (i.e., flowers, frogs, and caterpillars) (LoBue and DeLoache, 2008). Thus, it forms an evolutionary advantage to recognize dangers quickly and to react to them as efficiently as possible. Therefore, wilderness may also be partly associated with death and mortality (Koole and Van den Berg, 2005). On the other hand, research literature on preferences for natural settings shows that people generally prefer landscapes with a variety of landscape structures, open green spaces, differences in relief that enable views and orientation, as well as loose trees and the presence of water (Ulrich, 1993; Hill and Daniel, 2007).

Such preferences seem to relate not only to savanna but rather to mosaic environments (Domínguez-Rodrigo, 2014) and we develop this line of argument by first looking at the evidence on the preference of natural vs urban landscapes and then proceed to the preferred types and features of natural environments.

Several studies have consistently found empirical support for the assumption that people respond more positively to natural vs. urban environments (Staats et al., 2003; Van den Berg et al., 2003; Berto, 2005). Urban environments in these studies refer to human-made, built environments, such as streetscapes and buildings. Many links between human well-being and nature contacts have been analyzed and numerous studies have highlighted the positive effects of different kinds of green spaces on human health, well-being and quality of life (Hansmann et al., 2007; Abraham et al., 2010; Hartig et al., 2014; McMahan and Estes, 2015; Ideno et al., 2017; Twohig-Bennett and Jones, 2018; Bell et al., 2018; Grilli and Sacchelli, 2020; Rathmann et al., 2020; Rathmann, 2021). Supporting the notion of potentially hard-wired differences in brain activity, it has been shown that lower attentional demands for natural versus urban images can be detected within 1,200 milliseconds (Grassini et al., 2019; see also Norwood et al., 2019). Rapid positive emotional reactions to natural scenes versus negative reactions to urban scenes are evoked in 200 ms (Korpela et al., 2002). Savanna preference hypothesis also assumes that along with the preference reaction during evolution, a capacity for restorative, i.e., stress-reducing responding to certain natural settings has developed (Ulrich, 1993). This would foster amelioration of stress responses after encounters with danger and threats, such as predators. Ample evidence shows that stress-reducing physiological responses, indexed by, e.g., heart rate variability, salivary cortisol, blood pressure and pulse rate, are detected more rapidly after a stressful situation while walking or sitting in natural settings than in urban settings (Park et al., 2010; Bratman et al., 2012; Ideno et al., 2017; Twohig-Bennett and Jones, 2018; Mygind et al., 2019). The perception of environments' "naturalness" and its biodiversity has also been associated with the restorative qualities of a setting (Carrus et al., 2015).

To continue to the preferred types and features of landscapes, the theory of prospect and refuge can be traced back to the late nineteenth century and the anthropological belief in the human survival instinct leading to a stimulus, which directly connects human perceptions or reactions to environmental stimuli. The basic idea, that hominids have been living in the Savanna environments has started to be discussed since 1960, at least in archeology and history (Bender et al., 2012), underlining the paleoanthropological perspective of the Savanna theory. The psychological perspective of this theory focuses on the needs of the hominids for survival.

The prospect-refuge theory, proposed by Appleton (1975, 1996), describes a human behavioral and psychological need for places that allow a person to see, but without being seen. The basic idea was to show a simple model, relating preferences to a typology of landscapes based on behavioral and biological sciences. The whole model was "an agent of simplification for explanatory purposes" (Appleton, 1984, p. 92). The reduction was made deliberately to facilitate an explanation. Environmental perception is the key to all adaptation processes and humans perceive their environment in another way than

animals perceive their habitat. Some aspects of the habitat are more important for survival than others. "Prospect" and "refuge" are the important aspects of a landscape to improve the chances of survival. Further on, this theory tried to show a biological interpretation for landscape esthetics as it states that taste in art is an acquired preference for particular methods of satisfying inborn desires which are basically opportunity (prospect) and safety (refuge). Humans are attracted to specific circumstances (art, landscape) that have unoccluded vistas into the landscape (prospects further include hills, mountains and trees), visible places for easy refuge (e.g., climbable trees with dense canopies nearby, caves, dense vegetation) and additionally water, plants, prey species. Landscape preferences further include spaces, where we are rather on the edge than in the middle of a place, where we are most exposed and places where we are covered, compared to the open sky. Landscape preferences therefore focus on areas which are optimal for survival and reproduction. The Savanna Hypothesis (Orians, 1980; Bender et al., 2012) argues that selection favored resource-rich environments whereas environments, lacking resources or with survival threats have been avoided. Such environments offered the essential landscape characteristics for survival of the early humans; the availability of resources, protection against predators, the possibility of orientation and overview in space are central requirements for a landscape that ensures the survival of early humans. These theoretical conceptions actually propose that not only certain landscape contents but certain structural properties might have been important for the development of permanent preferences. One such property has been described as "depth/spaciousness" characteristics that relate to surveillance, proximity to hidden threats, and escape opportunities (Ulrich, 1993) or intermediate complexity or density of the scene (Joye and van den Berg, 2011). Such structural emphasis may also fit with alternative theoretical explanations for the Savanna Hypothesis, such as the Perceptual Fluency Account (PFA). It states that natural scenes are affectively evaluated more positively than urban scenes because our visual system more fluently processes certain aspects of the visual *structure* of the former than of the latter (Joye and van den Berg, 2011). In PFA, in contrast to psychophysiological and emotional theories supporting Savanna Hypothesis, it is the structure of the landscape, visual coherence and fractal patterns, rather than "unthreatening vegetated settings *per se*" that might explain preference of greenspace (Joye and van den Berg, 2011).

Emphasizing contents rather than structure, Heerwagen and Orians (1993) argue that our landscape preferences are innate, these preferences include open spaces of low grasses, the presence of water, flowering and fruiting plants, and evidence of animal life. Beside the prospect-refuge-theory and the Savanna Hypothesis, Kaplan's landscape preference matrix theory (Kaplan and Kaplan, 1989) and the stress recovery theory (Ulrich et al., 1991) argue that humans prefer natural green environments. More importantly and in line with the concept of mosaic environments, in addition to the Savanna hypothesis, two other hypotheses with respect to the specific habitat where humans have evolved have been presented (Han, 2007; Mangone et al., 2021). One option is the forest hypothesis, which argues that human evolution took place in closed, forested settings and the other one is the grassland–woodland hypothesis, which proposes that a mosaic of both settings was the adaptive environment for hominids.

Some of the empirical evidence for the preference for savanna environments is related to biomes as a whole but mainly it includes only some features of savanna environments. Concerning biomes, the evidence is mixed. In one study, photographs of five biomes, rain forest, deciduous forest, coniferous forest, savanna, and desert were rated by the inhabitants of the rainforest belt of Nigeria (Falk and Balling, 2010). The results showed that savanna scenes were regarded as the most favorable place to live. In another study, college students' psycho-physiological responses to the six major terrestrial biomes (desert, tundra, grassland, coniferous forest, deciduous forest, and tropical forest) showed that tundra and coniferous forest were the most favored biomes, whereas desert and grassland were the least favored (Han, 2007). Yet another study with a student population showed that irrespective of familiarity, beaches and lakes were preferred more and marshes and swamps preferred less than the other six biome types (beach, lake, tropical and temperate forest, marsh, swamp, meadow, park as a representative of savanna, mountain, and river) (Mangone et al., 2021). Concerning features of savanna, there is evidence on cross-cultural preferences for acacia-like Savanna trees (Orians and Heerwagen, 1992). Lohr and Pearson-Mims (2006) consider people's preference for trees with spreading cones comparable to an acacia. Sommer (1997) confirms this result within a cross-national study thus confirming the refuge dimension of Appleton's theory as such a canopy can represent habitat and safety. Anecdotal evidence points to the fact that looking at trees outside a hospital room helps in recovering more quickly from hospital stay than patients looking at a brick wall (Ulrich, 1984).

Moreover, the general question of the degree of our landscape preferences and behavior being innate versus learned during childhood is a part of a long debate. Humans have adapted to a broad range of conditions as social, cultural and natural selection unfold in tandem (Hartig, 2021). Thus, landscape preferences might be determined by culture as some studies stress a relationship between childhood memories and preferences for specific environments (Van den Berg et al., 1998) and others emphasize cultural determinants (Bourassa, 1992; Howley, 2011; Joye and van den Berg, 2011; Ward Thompson, 2018; Silva et al., 2020; Hartig, 2021). Landscape preferences, explained by cultural-based elements must first explain the concept of landscape, and these discussions have a very long tradition, especially in geography (Cosgrove, 2004; Wylie, 2007). The evolution of landscapes must be regarded as a reciprocal interplay of both ecological and cultural "factors." Carl Sauer's much-cited work on Sauer (1925) stresses the active agency of culture in shaping landscapes, rejecting environ mental determinism. Further, landscape is the esthetically perceived environment, therefore it affects human wellbeing. Wellbeing is regarded as an important factor in pro-environmental behavior across different cultures and countries (Capstick et al., 2022) stressing the importance of human-nature bonds for environmental policy.

Due to the complexity of the concept of landscape, it must be distinguished from concepts such as place, space, or territory

in a political context (Menatti and Casado da Rocha, 2016). Landscape is the existentially experienced environment as a result of history, reflecting economy and society. And so are landscape preferences in this perspective.

The discussions about the different concepts of landscape are far beyond the scope of this contribution but such concepts of landscape offer the possibility of reconnection ecology, and psychology to current humanities concerns with culture, identity, meaning, and even ethics (Menatti and Casado da Rocha, 2016). Environmental psychology is increasingly recognizing that human–environment interactions are culture-bound (Tam and Milfont, 2020), thus discussing the cultural factors in landscape perception, preferences, and individual wellbeing.

Hartmann and Apaolaza-Ibáñez (2013) confirm the role of familiarity as there are preferences for images of lush green landscapes with water and familiar biomes (see also Mangone et al., 2021). Human nature attachment has been related to both evolution and cultural bonds to places, as landscape preferences are related to places where human beings feel safe and at home (Adevi and Grahn, 2012). Differences in preferences for nature between demographic groups appear to be small (Stamps, 1999) but differences in landscape preferences between Western students and non-Western students have been found (Hägerhäll et al., 2018) or preferences for tropical forest landscapes (Moura et al., 2018). Also, age-related changes in landscape preferences have been found (Balling and Falk, 1982). Following from this "innate-learned debate" and the complex mix of social, cultural, and natural selection, our focus in this paper on a special preference for certain types of natural settings does not exclude or oppose potential preferences for (or evolutionary adaptation to) urban settings; neither do we maintain that preferences (= visual inclinations to prefer) for nature *per se* necessarily signify particular health benefits from nature (cf. Hartig, 2021). Although there is ample evidence that such health or wellbeing benefits do exist particularly in comparison to urban scenes (Abraham et al., 2010; Hartig et al., 2014; Twohig-Bennett and Jones, 2018; Mygind et al., 2019) we emphasize here Ulrich's (1983) theoretical notion that an individual's affective reaction to a natural scene serves only as an action impulse for adaptive behavior which can be suppressed or denied, based on experience and learning.

To conclude, empirical evidence for preference for savanna-like environments is only partial and several types and features of natural environments attracting human preference have been presented. Thus, a very important and interesting observation in this respect is Domínguez-Rodrigo's (2014) notion, based on palaeoecological evidence, that Savannas should be regarded as mosaic environments and not as open grasslands.

Several studies also show that human evolution took place in different biomes and not only in savanna environments. Hominids evolved in East Africa in an ecologically diverse setting, including grassland, savanna and different forest structures (Kingston et al., 1994). But whereas the early Miocene mammalian faunas had a tropical-forest character, the Pliocene shows more faunas evolving a savanna-mosaic character (Cerling et al., 1997). But as the interactions between climate change, ecology, and evolution are rather complex, more studies are needed to investigate this complex interplay (Blumenthal et al., 2017).

We will further explore the possibilities of extending the Savanna Hypothesis including various environments with various structural properties, such as prospect and refuge, from an evolutionary perspective. With all the uncertainty in the reconstruction of the palaeoenvironmental conditions during hominization, the Savanna Hypothesis could be given new perspective by investigating the Pleistocene.

## BEYOND SAVANNA

In the warm periods of the Pleistocene, many of the northern hemispheric forest areas were apparently open woodlands with large open spaces, structurally somehow similar to Savannas. Based on the mega herbivore hypothesis, the forests were then under high grazing pressure from mega herbivores, i.e., large herbivores (e.g., forest elephants, forest rhinos, giant deer), which, depending on the author, are defined as weighing more than 800, 900 or 1,000 kg (Malhi et al., 2016; van Valkenburgh et al., 2016). During the Pleistocene cold periods, however, largely open landscapes with other mega herbivores (e.g., wooly mammoths, wooly rhinoceroses, musk oxen, giant sloths) dominated. Generally, an alternation between open steppe/tundra and forested landscapes took place affecting human evolution (Sanchez Goñi, 2020). Within a glacial period, warmer phases occurred in which not only tundra or steppe biomes were present, but also some patches of woodland and shrub stands leading to a complex mosaic of different plant communities. The best modern analog for this Pleistocene steppe-tundra environment is located in the Altai Mountains (Chytrý et al., 2019). **Figure 1** illustrates the complex interactions of mankind, climate change, the impact of megaherbivores on the landscape structures and the subjective perception of landscape.

At the time of the last cold period, the early modern human settlement of southern Central Europe occurred during Marine Isotope Stage 3 in a medium-cold steppe-like environment with some boreal trees at climatically favorable sites (Nigst et al., 2014). The rare palynological studies of Southern Central Europe confirm this vegetation reconstruction (Brande, 1982; Müller et al., 2003; Stojakowits et al., 2021; **Figure 2**). Bielinis et al. (2018, 2019)—based on the salutogenic landscape preference framework—have shown that even snow-covered forests and broad–leafed forests in winter can trigger positive emotions and can lead to psychological relaxation. Another study suggests lowering of blood pressure and even immune system effects of forests in winter (Peterfalvi et al., 2021). Thus, we propose that Late Pleistocene environments might have partly contributed to the development of landscape preferences, although the most ancient preferences of *Homo sapiens* were formed in Africa during the two last glaciations (Riss and Würm) and interglacial stages (Mindel-Riss and Riss/Würm). The first traces of modern humans date to around 315,000 years ago (Richter et al., 2017).

According to genetic studies, modern humans likely mixed with Neanderthals (Prüfer et al., 2014). Both, the early modern humans and the Neanderthals were shaped by open landscapes

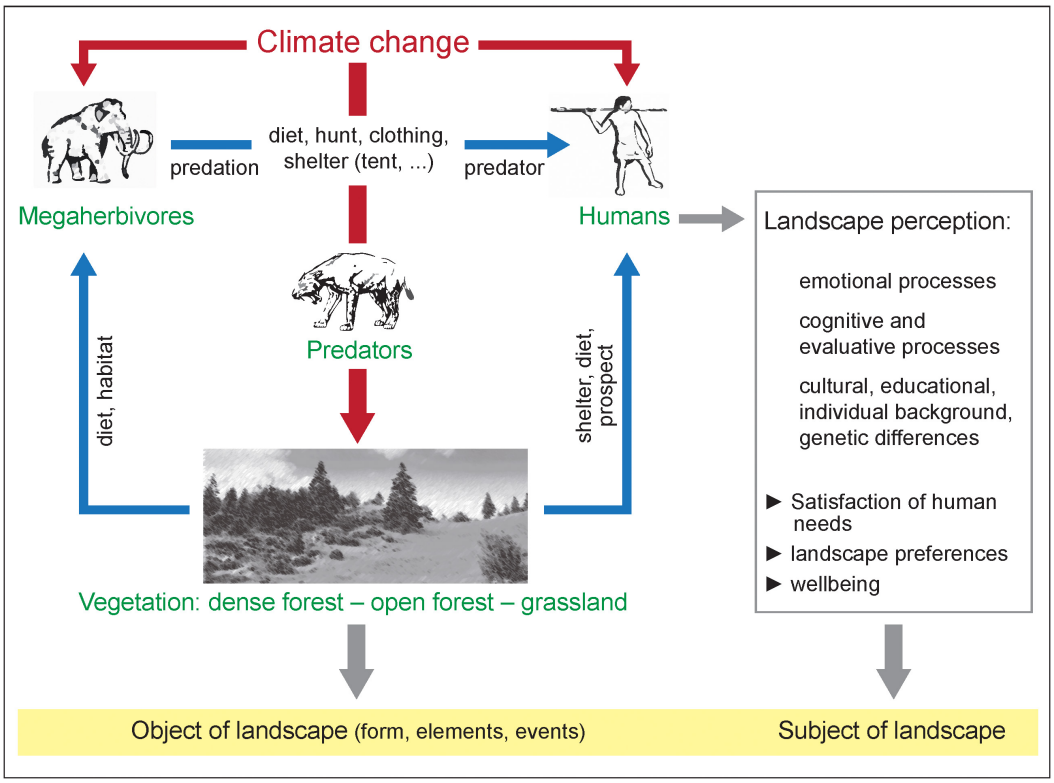


**FIGURE 1 |** The simplified depiction of the interactions of mankind, climate change, the impact of mega herbivores on the landscape structures and the subjective perception of landscape. The focus is on the interactions between climate and the biosphere with human forcings affecting the environment and actively shaping their environment. Source: Winfried Weber, Institute of Geography and Geology, University of Würzburg, 2022. Reproduced with permission.

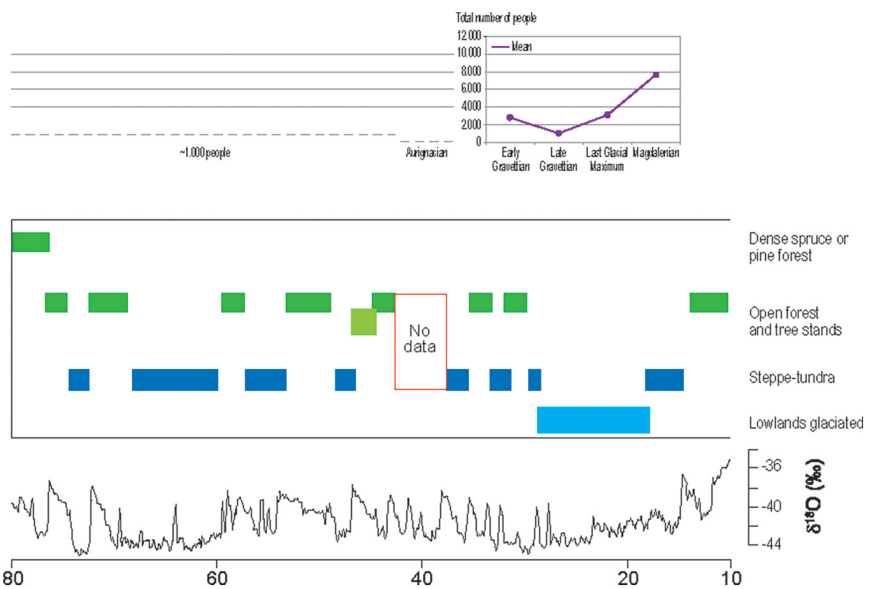


**FIGURE 2 |** Vegetation and palaeoclimatic development in comparison to the estimated population from c. 80 to 10 ka (x axis). According to Heiri et al. (2014), with additional palaeobotanical data (Müller et al., 2003) and estimated total number of people for the Upper Danube region until c. 42 ka (Müller-Beck, 1983), for the same region during the Aurignacian until c. 33 ka (Schmidt and Zimmermann, 2019), the early Gravettian until c. 29 ka and late Gravettian until c. 25 ka (Maier and Zimmermann, 2017), the LGM (Maier et al., 2016), and Magdalenian (Kretschmer, 2015; Maier, 2017). The Greenland ice core oxygen isotope record NGRIP is shown in the lower part of the figure according to Svensson et al. (2008), supplemented by Rasmussen et al. (2014).

over many generations. After the ice retreat Mesolithic tribes lived in open landscapes until the reforestation with *Betula* trees took place in the Bølling Interstadial at around 14.5 ka (Eusterhues et al., 2002). Later on, *Pinus sylvestris* also reimmigrated forming open pine-birch-forests until the onset of the Boreal at around 10.3 ka. Around 5,500 cal BC, the colonization of Neolithic tribes of the Linearbandkeramik (LBK) along the Danube started in Southern Central Europe (Gronenborn, 2004). These people used to live in open grass steppe landscapes as testified by pollen analyses (e.g., Wick et al., 2003; Litt et al., 2009). They created similar kinds of open landscapes in their newly settled areas on a small scale- which were densely forested at that time—in order to practice farming. Open lands are preferred settlement regions for humans over many thousands of years dating back to the Late Pleistocene. Although wilderness seems to be more fascinating than cultural landscapes (Barbiero and Berto, 2021) domestication of animals and plants during the Neolithic period might have contributed to favoring the cultural landscapes, over the wilderness landscapes.

## CONCLUSION

Although the Savanna Hypothesis can be questioned in many ways, it may be extended by the integration of Pleistocene environments. Our hypothesis is, that the preference for mosaic, park-like landscapes experienced a kind of "refreshment" in the Pleistocene. We suggest a heuristic tool, as Appleton did, and not a comprehensive explanation of human behavior and perception, being aware that landscape preferences are not simply based on innate response to the environment. The extended Savanna Hypothesis, termed "Beyond-Savanna-Hypothesis" or according to our study "Pleistocene-Mosaic-Environments-Hypothesis," might also stimulate work linking human evolution, human health, and general human-environment bond (c.f., Mangone et al., 2021; Chang et al., 2022). We propose empirical studies that would account for both genetic, environmental and developmental influences and their complex interactions on such preferences.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## AUTHOR CONTRIBUTIONS

JR: basic idea, literature review, and text. KK: text on psychology. PS: text on paleoenvironments. All authors contributed to the article and approved the submitted version.

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# Impact of Contact With Nature on the Wellbeing and Nature Connectedness Indicators After a Desertic Outdoor Experience on Isla Del Tiburon

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Nature connectedness is determined by the representation individuals have about themselves within nature. This concept is often studied in relation to the direct contact individuals have with natural environment, which according to some studies have demonstrated to generate positive effects by fostering a feeling of connecting and bonding with nature, as well as improving their wellbeing. The main focus of this study was to calculate and assess the relation between Nature Connectedness and wellbeing of participants. The methodological approach of this research reaches quantitative data comparing results obtained from both samples, as well as correlations between the variables. The sample for this study was composed by two groups of university students ($M$ = 25 years old). Both contrast group ($n$ = 32) and experience group ($n$ = 29) filled the questionnaire in two separate moments and in different environments. First data collection moment for both groups was held inside a university classroom. A second moment of data collection was carried out after a month from the first application, having the contrast group answer the questionnaire on a classroom again whilst the experience group responded it during an excursion to Isla Del Tiburon in Northwestern Mexico after performing some recreational activities being totally immersed in a local desertic environment. Questionnaire was composed by a 6 point Likert type scale measuring Nature Connectedness through concepts such as Nature relatedness and Love and care for the natural, as well as Subjective and Psychological Wellbeing of participants. Results show that both wellbeing and Nature Connectedness are positively influenced by performing activities out in the natural environment. This work was also conducted in response to the need to understand the full extent of Contact and Connectedness to nature, carrying out an exploratory study in desertic settings when much of the early work centers around the study of these variables in green nature environments.

**Keywords: nature connectedness, wellbeing, natural environment, contact with nature, desertic environments**

## INTRODUCTION

Individuals often receive positive effects after being in contact with nature. Experimental studies have shown how this contact arise while interacting with plants, animals, natural views or walking on nature (Morita et al., 2007; Hinds and Sparks, 2008; Müller et al., 2009; Duerden and Witt, 2010; Collado and Corraliza, 2016; Izenstark et al., 2021). This contact brings direct effects on each individual affective, emotional, and psychological strands, among others.

Certainly, contact with nature occurs while an individual interacts with any natural component or is surrounded by a natural environment. Certainly, these interactions are diverse, and they may include various activities such as mountain biking on the forest, indoor hiking on a virtual simulated jungle or even working on an office with a panoramic view of the greenery outside. Consequently, humans benefit from this interaction enhancing their connectedness to nature, integrity, vitality, wellbeing amongst others. Thus, contact with nature is considered as a key predictor to an individual level of Nature Connectedness (NC) (Mayer and Frantz, 2004; Olivos et al., 2011).

Contact with nature has been frequently studied in contexts such as psychology and environmental education, these seek to explain the attainment of benefits of an affective connection to the natural environment (Millar and Millar, 1996; Hinds and Sparks, 2008; Müller et al., 2009; Duerden and Witt, 2010; Collado and Corraliza, 2016).

There exists a very extensive literature on the topic of the relationship between environmental identity and self-identity. A large body of work has approached this variables with different measures, concluding that there is indeed a strong correlation between the aforementioned elements and furthermore, with them also being related to different measures of nature connectedness (Brügger et al., 2011; Tam, 2013; Restall and Conrad, 2015; Martin and Czellar, 2016; Olivos and Clayton, 2017; Balundė et al., 2019).

Additionally, widely reported studies can be found about the beneficial or detrimental effects of the human-nature relationship regarding the degree of connection and lifestyle choices of individuals (Seymour, 2016). According to Kaplan and Kaplan (1989) the fondness people may display for natural environments vary according to individual differences. Said preferences range from birdwatching and contact with animals and plants to walking or "Forest bathing" (Translated from *shinrin- yoku,* Kotera et al., 2020).

This connection is referred as a significant predictor of intentions that conduce people to interact with the natural environment in a certain way. Moreover, NC can have a varying influence on the development of the environmental concern, as is required to perform a comparison between having a direct experience with nature and another with an indirect contact (Collado and Corraliza, 2016). Olivos and Aragonés (2014), to study NC of individuals and Inclusion of Nature in Self (INS) both in natural and built environments, established that there is a distinct augmentation in people NC after being exposed on a natural environment.

Previous studies assessing Contact with nature or natural environment attitudes, usually take place on green backgrounds (e.g., parks, woods, forest). However, this study is executed on the Isla Del Tiburon, a climate with characteristics of the arid Sonoran Desert located in northwestern Mexico (see Supplementary Photographs and Map).

This study aims to explore individuals' nature connectedness that are not in contact with nature and therefore, do not have any kind of interaction outdoors at the moment of being assessed, compared to those who are in direct contact with nature and are evaluated while being exposed to outdoor activity considering that the environment presents extreme conditions (e.g., high exposure to sun, dry weather, hot temperatures, lack of sanitary amenities, pathway trails on the island).

The present study has the purpose of analyzing the level of nature connectedness and wellbeing individuals display when surrounded by this particular scenery. Our work seeks to test whether contrast and experience groups present significant differences regarding their levels of nature connectedness and Psychological Wellbeing. We have hypothesized that outdoor activity and being in direct contact with nature on Isla Del Tiburon can positively enhance individual nature connectedness. Accordingly entailing, the experience group will develop a higher sense of feeling closer to nature, a better perception of feeling satisfied with life, as well as having positive emotions.

### Contact With Nature: An Approach to Nature Connectedness

Being connected to nature or the NC construct is the sense and level of belonging humans have with the natural world (Schultz et al., 2004). This term is the result of analyzing the self-nature bond, and it suggests a perception perceived as an extension of the cognitive representation that all humans have, given an individual belief of being part of nature. This determines the concern Individuals with higher sense of kindness will develop and the circumstances under which they will come to action toward nature. This conceptualization gained attention in the 1950s, when there was a surge in the interest in meditation and the natural environment, its concern, and the bonding people have with it; but it was not until the 1990s when scientists coined the term.

This concept of NC is enriched by several proposals that comprise the concept such as Nature Relatedness (NR), which Nisbet et al. (2009) suggested a new construct based on the relatedness or relationship with nature to describe the levels of connectedness individuals have with natural world. This proposition constitutes the appreciation and comprehension people have toward other living things on the planet and surpasses the principles of environmentalism as it is a more dynamic concept that does not simply suggest pleasure or love for nature, but a complex understanding of the importance of the natural environment in diverse levels and aspects. The concept of NR describes individual levels of NC and is similar to the fundamental concept of ecology, which consists of a notion of self-construction included in nature.

Another idea that integrates to NC is Love and Care for Nature (LCN) by Perkins (2010), which estimates the level of feeling connected with nature and the personal fulfillment attained by it. This arises after analyzing an affective aspect about the relationship between nature and human beings contributing to "environmental altruism," and is built upon developing an integral love and care for nature, as well as recognizing its intrinsic value and acquiring a sense to protect it.

According to Schultz et al. (2004), the NC that emanates after bonding the self and nature is related to the way individuals see themselves within nature, in addition to a set of motivational believes that will promote the emergence of environmental behaviors. This means that each person will estimate nature from their own cognitive representation followed by acquiring a type of environmental concern, being subsequently motivated to act in a certain way toward nature (Olivos and Aragonés, 2014). This idea is known as Inclusion of Nature in Self (INS) by Schultz (2001).

## Nature Connectedness

Several types of environmental concerns and situations have been addressed as individual motivators of nature's behavior caused by an internal belief in how people position themselves within the natural world (Schultz et al., 2004). On one side, there is the individual that accepts itself as an element apart from nature and considers people to be exempt of the nature kingdom by considering themselves as superior to plants and animals. Oppositely, there is the individual that perceives itself to be a part of nature equal to animals, and that the same rights that humans have, apply just as well as they do to other living organisms. NC represents the integrity of an individual with the natural world, following Leopoldo's idea that people need to feel part of a natural environment if they desire to properly engage in environmental problems or feel related to nature.

By comprehending the NC concept as an identification of how individuals perceive themselves toward the natural environment, authors suggest this condition is also important when estimating the human-nature relationship. Natural environments are often related on significance to contact with nature, which genuinely portrays a crucial aspect on the individual level of connectedness to nature (Nisbet et al., 2009). Regarding these environmental interventions, researchers indicate substantial contact with nature might enhance self- perception within nature, being connected to a natural world and as a part of it from an early age (Barrable and Booth, 2020; Pirchio et al., 2021).

## Nature Connectedness and Wellbeing

The benefits of being exposed to natural environments seem to be mediated by the sense of belonging, integrity, and NC (Mayer and Frantz, 2004; Olivos et al., 2011). Environmental Psychology has studied the effects of NC in relation to variables such as wellbeing, restoration, stress, or fatigue. The study of the psycho-emotional and physical benefits that stem from this contact has led to relevant findings like Kasap et al. (2021) who assert that nature as a whole has enormous effects on the human being cognitive functioning as improvements on wellness, stress, and anxiety (Fong et al., 2018; Ameli et al., 2021; Reese et al., 2021). Izenstark et al. (2021) also reference this by associating being in a natural environment to emotional wellness benefits, whether it be adults or children (Bowler et al., 2010; McMahan and Estes, 2015; Ward et al., 2016). PW is also significantly influenced by visiting urban parks and green areas or performing activities in them. These spaces include reserves, fields, communal gardens, and natural conservation areas (Roy et al., 2012; Loureiro and Veloso, 2014). Conversely, Song et al. (2017) performed a study ($n$ = 20) where they implemented forest bathes in which participants increased their levels of calmness and relaxation after the activity while Pirchio et al. (2021) performed a study ($n$ = 407) here they ascertained participants' NC rising after completing a program of outdoor activities in a natural area.

## Wellbeing and Natural Environments

When studying the effects of NC related to variables such as wellbeing, the focus is to investigate if the environment on which interactions occur brings some effects (e.g., happiness, vitality, relaxation) and if so, in which way. For this, two philosophies try to measure and conceptualize the term by promoting a debate with theoretical and practical implications.

While Ryan and Deci (2001) define wellbeing as the optimal functioning and psychological experience of individuals, Subjective wellbeing (SW) studies the reason and way people positively experience their lives while including cognitive judgments such as affective reactions (Diener, 1994). De Sade believed that this kind of search for a sense and pleasure is the goal of human life (Ryan and Deci, 2001). Contrastingly, Psychological wellbeing (PW) has its philosophical origins in the works of Aristotle, who characterized eudaimonia because of people's lives according to their own values and their self-realization (Waterman, 2008; Pritchard et al., 2020). Thus, it is important to mention that individuals that perceive themselves as being more intricately connected to nature often register higher indices of eudaimonic wellness, particularly regarding their personal growth. Studies acknowledge different results after measuring wellbeing and NC because of differences in aspects within wellbeing that are considered when relating it to NC (Howell and Passmore, 2013; Capaldi et al., 2014; Pritchard et al., 2020); such is the case of results obtained after studying eudaimonic wellbeing with NC, since they confirm the bond between these two aspects may be stronger than the one between NC and hedonic wellbeing (Howell et al., 2011; Capaldi et al., 2014).

Exposure to nature may have a positive influence on psychological constructs as well, such as boredom, sympathy, wellbeing, and liveliness (Morita et al., 2007; Lim et al., 2020) in addition to raising personal levels of energy and vitality (Ryan et al., 2010). Similarly, there is an improvement on expressing feelings or emotions while being surrounded by nature as proven by Kaplan and Talbot (1983), who claim that when people find themselves in wild environments they report feeling "alive" and engaged with nature, in conjunction with scoring notably higher relaxation indicators (Hansen et al., 2017; Lim et al., 2020).

Studies confirm that being outdoors and in contact with the natural environment is a way for people to satisfy their needs of

having direct experiences in a natural world; while cognitive and emotional experiences are associated to having positive effects on their wellbeing (Tauber, 2012). In Singapore, Lim et al. (2020) implemented what is known as a "forest bathing" to measure exposure to the woods for a period and its effects. On this study ($n$ = 51) participants gathered on a guided walk through the forest answering an instrument that included scales such as Nature Connectedness Scale (NCS), where the results were positive on people' NC, as well as to some positive aspects in their emotions through PANAS (Positive and Negative Affect Schedule). Regarding subjective wellbeing scales, PANAS is used to determine people's SW and often applied in experimental studies to evaluate changes in affections before and after some outdoor activity reporting benefits in affective aspects (Bowler et al., 2010; McMahan and Estes, 2015; Izenstark et al., 2021). Another common way to capture SW it is measuring through Satisfaction with life (National Research Council, 2013). Being exposed to nature or being outdoors a strong predictor from this concept (Kaplan, 1993; Biedenweg et al., 2017). The presence of natural elements (e.g., animals, plants, views) often create a greater life satisfaction on people at diverse environments; Kaplan (1993) found that satisfaction increased with a natural view from peoples' home (Russell et al., 2013).

## Natural Environment: Tiburon Island

Simmons (1993) defines natural environment as everything that surrounds us that is not human; and from this definition spreads the dichotomy of what is a result of human influence and what remains untouched. Kaplan and Kaplan (1989) define the term "natural environment" and refer to it as "nature" encasing the meaning of a group of living and non-living elements that constitute a habitat composed by spaces and resources where there are no human being traces found. This idea corresponds to a continuum where one edge is the natural environment and the opposite is a built environment, according to Aragonés and Amérigo (2000).

In this same notion, Isla Del Tiburon is a natural environment, and it is located in the Gulf of California, in northwestern Mexico. It has a surface area of 1,208 km$^2$ and is characterized by having a dry climate and two mountain ranges: Sierra Menor and Sierra Kun Kaak. Local vegetation is comprised over 298 species from the Sonoran Desert (Rojas et al., 2002). Moreover, it is a site of high biological productivity, with areas for nesting, and mating and breeding of marine species. It is the largest island in the country and has been labeled as "biosphere reserve." In addition, it is part of a UNESCO World Heritage Site and belongs to one of the ethnic groups in the region called "Seri" (Konkaak), comprised by 700 people (II Conteo de Población y Vivienda in Acosta, 2002). This ethnic group bases its cultural manifestations tributing nature, sea, animals, and the different stages of human beings and life cycle. The island is part of Seri territory and is considered one of the last territories of the Sonoran Desert that remains untamed. Therefore, Isla Del Tiburon represents a perfect setting to assess what this study aims, considering closeness to the city (approximate a 50 miles drive) and being a desert virgin territory full of natural panoramas.

# METHODOLOGY

This study is performed under a quantitative methodological approach as it sustains a set of processes that implement techniques of quantitative measurement and statistical analysis. Furthermore, it is a quasi-experiment that focuses on the dependent variables that have been collected in pre-organized conditions in order to describe the way or reason of the presented situation or phenomena (Tamayo, 1980). This is a descriptive and comparative study analyzing situational variables, which consists of observing certain characteristics participants present in two different environments and two different periods of time: classroom and/or a natural environment (Island), 1 month after answering the initial questionnaire.

## Participants

Sample is composed by two student groups, both enrolled in the Psychology School Program at the University of Sonora in Mexico. The "Contrast group" corresponds to 32 students from 18 to 36 years old ($M$ = 24 years old) enrolled in the undergraduate psychology program that were part of a course and were already gathered at the classroom while "Experience group" to 29 students aged 18 to 36 years old ($M$ = 23 years old) composed by undergraduate and graduate students from the same program and were invited to the excursion. Both samples were openly invited to participate in this study and accepted voluntarily to be part of it.

## Instrument

A 68-item instrument was used and adapted on this study and is comprised by seven scales. Participants' Subjective Wellbeing (SW) is studied with the Positive and Negative Affect Schedule (PANAS); it is a list of adjectives that name emotions as positive and negative affects of people in particular situations. It was designed by Watson et al. (1988) and consists of a total 20 items in Likert-type scale divided on two scales: PA and NA, which correspond to positive affects and the negative. This scale presented high internal consistency ($\alpha$ = 0.80). Correlation between the two affect factors (positive and negative) is low, ranging from -0.12 to -0.23, so they are interpreted as independent (Watson et al., 1988). This two-factor model demonstrated a good fit (Zevon and Tellegen, 1982; Crocker, 1997; Terracciano et al., 2003). PANAS Currently has been validated in Mexico (Robles and Páez, 2003 as shown in Moral, 2011).

Participants must choose from a range (1 = nothing–5 = very) if they feel inspired, anguished. Satisfaction with life Scale (SWLS) (Diener et al., 1985) was also used to measure SW, it consists of five items that evaluate the self-perception people have about how satisfied they are with their own lives. It contains statements such as "In most aspects, my life is how I want it to be" with a range of answers (1 = strongly disagree–7 = strongly agree).

To measure the NC variable the Nature Connectedness Scale (NCS) by Mayer and Frantz (2004) was used on its seven-item adaptation (Pasca et al., 2017), which measures the subjective cognitive connection between individuals and nature. NCS has accounted high internal consistency ($\alpha$ = 0.84) It

contains statements such as "I often feel related with animals and plants with a range of answers" (1 = strongly disagree–7 = strongly agree).

Moreover, Love and Care for Nature Scale (LCN, α = 0.90) by Perkins (2010) was employed to report statements such as "I feel a deep love for nature" with a Likert-type 15 item scale (1 = strongly disagree to 7 = strongly agree).

Nature Relatedness Scale (NRS) created and validated by Nisbet et al. (2009) was also added as a Likert-type scale with 6 items (α = 0.87). This scale relates people and their preferences of subjects about nature and their level of comfort in the environment with statements such as "My connection to nature and the environment is a part of my spirituality" and "I always think about how my actions affect the environment" with a range of options (1 = strongly disagree–7 = strongly agree) to mark as their personal alignment.

Schultz's Inclusion of Nature in Self (INS) (2001) one-item was added to measure construction of self within nature. INS consists of a range of options of seven pairs of circles, with left circle labeled as "Self" and the right one under "Nature." Each group gradually overlap until being completely one circle option (1 = Self and Nature are totally separate–7 = Self and Nature represent a whole same circle). With this item, participants are asked to choose the pair of circles that best represents their sense of being connected to the natural world. This item could not receive a factor analysis as it is a single item instrument.

Wellbeing is measured with the Psychological Wellbeing Scale (PWS) by Ryff (1989) where 29 items relate to people life achievements as "I feel good when I think about what I have done in the past and what I expect to do in the future" and a range of answers (1 = strongly disagree–7 = strongly agree).

Additionally, sociodemographic items were added (e.g., gender, age).

## Procedure

Two different groups conformed this research, one contrast and one experience. The experience group was previously selected after they signed in over an open-call that took place in the Psychology department at the Universidad de Sonora where the public was invited to an experience of contact with nature. Contrast group was comprised by undergraduate students from the Psychology department as well as those who chose not to partake in the outdoor activities.

Data collection process was executed in two different settings. First, Contrast and Experience groups responded to a printed instrument at a university classroom while sitting at their desks on regular schedule taking 15 min to answer it. At that moment, participants had not had any contact with nature at all while answering the test. Second data collection moment was held a month after the contrast group had responded to the questionnaire in same classroom on a built environment.

Contrarily, experience group answered the test immersed in nature after an excursion in Isla Del Tiburon, where they took a 2-mile walk along the island watching local desertic flora and fauna and being surrounded by mountains and the sea. At boarding area, sitting on sand and under palm trees participants answered to the printed questionnaire by hand in approximately 15 min.

## Data Analysis

Firstly, instrument reliability was tested by Cronbach's Alpha (α). Then, collected data was analyzed using statistical package SPSS version 21.0, through an exploratory factorial analysis, descriptive statistics, independent samples *T*-test t and correlates between variables were computed.

# RESULTS

A reliability test was executed indicating good consistency between instrument application in both groups as well as periods (**Table 1**). Data analysis was performed, and as H1 predicted, no differences were found in pre-excursion section in between groups referring that indeed, both groups have similar feelings toward nature and were feeling satisfied at the moment. As H2 established, some constructs of NC and wellbeing registered an increasement regarding the experience group in the second phase due to higher results on INS, CNS, NR, and LCN for NC variables. Also, PW and PANAS related to the wellbeing construct, showing differences with the contrast group at the same stage.

INS frequencies (see **Table 2**), shows how related the person feels to nature at the moment at the moment they answered questionnaire, noticing higher frequencies in item 6 regarding the experience group on the post-excursion phase by difference to contrast group diversifying answers.

Descriptive statistics were computed for each group by obtaining M and Standard deviation from both groups and phases as displayed (see **Table 3**). As dividing PANAS in two sections, Positive affects from PANAS indicate experience group registered responses such as having more positive emotional affects when answering the questionnaire surrounded by nature. As for the post-excursion phase results also showed reduced negative affects, meaning they felt less aggressive, anxious, and anguished than our contrast group in this phase. In SWL, the experience group seemed to be more satisfied with their lives, their own choices and circle of friends than the contrast group. NCS showed that the experience group had a closer experience with nature, feeling part of the natural world and of the life cycle. NR indicated that

**TABLE 1 |** Cronbach's Alpha reliability test.

| | Pre- excursion | | Post-excursion | |
|---|---|---|---|---|
| **Scale** | **Contrast** | **Experience** | **Contrast** | **Experience** |
| Positive affects schedule (PANAS) | 0.851 | 0.866 | 0.838 | 0.916 |
| Negative affects schedule (PANAS) | 0.894 | 0.823 | 0.830 | 0.862 |
| Nature connectedness scale | 0.933 | 0.781 | 0.929 | 0.875 |
| Nature relatedness scale | 0.838 | 0.783 | 0.847 | 0.850 |
| Love and care for nature scale | 0.947 | 0.956 | 0.968 | 0.953 |
| Satisfaction with life scale | 0.0873 | 0.845 | 0.919 | 0.866 |

**TABLE 2 |** Inclusion of nature in self item frequencies.

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| | | Self-nature | Self-nature | Self-nature | Self-nature | Self-nature | Self-nature | Self-nature |
| **Phase** | **Group** |  |  |  |  |  |  |  |
| Pre-excursion | Contrast | 0 | 1 | 6 | 8 | 9 | 6 | 2 |
| | Experience | 0 | 3 | 2 | 12 | 5 | 6 | 1 |
| Post-excursion | Contrast | 0 | 3 | 5 | 6 | 8 | 7 | 3 |
| | Experience | 0 | 0 | 1 | 4 | 8 | 13 | 3 |

**TABLE 3 |** *T*-test results.

| Scale | Phase | Group | *M* | *t* | *d.f.* | *p* | *r* |
|---|---|---|---|---|---|---|---|
| Positive affects (PANAS) | Pre-excursion | Contrast | 3.44 | −0.83 | 59 | 0.67 | |
| | | Experience | 3.58 | | 59 | | |
| | Post-excursion | Contrast | 3.56 | −3.47 | 59 | 0.00 | 0.10 |
| | | Experience | 4.00 | | 59 | | |
| | Pre-excursion | Contrast | 4.45 | 0.15 | 59 | 0.58 | |
| Negative affects (PANAS) | | Experience | 4.43 | | 59 | | |
| | Post-excursion | Contrast | 4.45 | 4.02 | 59 | 0.00 | 0.001 |
| | | Experience | 3.76 | | 59 | | |
| | Pre-excursion | Contrast | 5.40 | −1.79 | 59 | 0.74 | |
| Satisfaction with life | | | | | | | |
| | | Experience | 5.81 | | 59 | | |
| | Post-excursion | Contrast | 5.41 | −1.70 | 59 | 0.09 | 0.22 |
| | | Experience | 5.84 | | 59 | | |
| | Pre-excursion | Contrast | 5.25 | −0.57 | 59 | 0.25 | |
| Nature connectedness | | | | | | | |
| | | Experience | 5.39 | | 59 | | |
| | Post-excursion | Contrast | 5.37 | −1.21 | 59 | 0.22 | 0.07 |
| | | Experience | 5.68 | | 59 | | |
| Nature relatedness | Pre-excursion | Contrast | 4.86 | −1.28 | 59 | 0.59 | |
| | | Experience | 5.18 | | 59 | | |
| | Post-excursion | Contrast | 4.99 | −2.07 | 59 | 0.04 | 0.03 |
| | | Experience | 5.48 | | 59 | | |
| | Pre-excursion | Contrast | 5.40 | −0.17 | 59 | 0.96 | |
| Love and care for nature | | | | | | | |
| | | Experience | 5.45 | | 59 | | |
| | Post-excursion | Contrast | 5.40 | −2.08 | 59 | 0.04 | 0.02 |
| | | Experience | 5.91 | | 59 | | |
| | Pre- excursion | Contrast | 5.38 | 1.98 | 59 | 0.83 | |
| Psychological wellbeing | | Experience | 4.97 | | 59 | | |
| | Post-Excursion | Contrast | 5.27 | 0.29 | 59 | 0.77 | 0.24 |
| | | Experience | 5.21 | | 59 | | |

the experience group displayed a greater preference about being surrounded by nature and feeling more comfortable in this environment than the other group. LCN showed that contrast group scored $M$ = 5.40 and the experience group $M$ = 5.91.

This result goes to show that even if the contrast group had a moderately high M score, the experience group had a higher level of feeling passionate for the natural world, more spiritually close to Earth, and caring more the planet when being surrounded by nature. PW in contrast group obtained $M$ = 5.38 and the experience group $M$ = 5.21 demonstrating contrast group has a higher level of satisfaction about their achievements and objectives as people. Also, to compare means between samples, an independent sample $T$-test was made reporting significant comparison between contrast and experience group means on PANAS, LCN and NR each on the second phase (see **Table 3**).

Correlates indicate an outstanding interrelation (see **Table 4**) of LCN and NR as well as the correlation of LCS with NCS and NR with NCS. Also, to be highlighted are the strong correlates between NR and SWL, SWL and NCS, and SWL and LCN when testing study variables.

**TABLE 4 |** Variable correlates.

| Scale | PANAS | SWLS | NCS | NRS | LCN | PWS |
|---|---|---|---|---|---|---|
| Positive and negative affects schedule | | | | | | |
| Satisfaction with life scale | 0.147 | | | | | |
| Nature connectedness scale | 0.085 | 0.366** | | | | |
| Nature relatedness scale | 0.199 | 0.404** | 0.674** | | | |
| Love and care for nature scale | 0.241 | 0.319* | 0.703** | 0.797** | | |
| Psychological wellbeing scale | 0.239 | 0.223 | 0.149 | 0.181 | 0.104 | |

**p < 05, **p < 0.001. PANAS, Positive and Negative Affects Scale; NC, Nature Connectedness; NR, Nature Relatedness; LCN, Love and Carefor Nature; SWL, Satisfaction with Life; PW, Psychological Wellbeing.*

## DISCUSSION

The findings in this study imply that being surrounded by natural environments actually contributes to improving individual levels of NC, emotions, and wellbeing. In particular, Isla Del Tiburon presents peculiar conditions that provide positive elements to people as participants in this study reported significant results in some scales. Data collection settings between the two groups differed markedly in order to encompass the impact that the experience group had on its persona and nature concerns, as opposed to the contrast group which responded to the questionnaire in a regular indoor classroom environment.

This study offers a broader panorama of Environmental Psychology and Ecopsychology, which ensures that people benefit from being in nature. These findings also contribute to the fact that arid regions such as the Sonoran desert, despite the hot weather and exotic vegetation, actually provide a large list of assets to human feelings and insights.

The experience group got higher scores in PANAS regarding an improved SW compared to contrast group in the post-excursion phase. Participants who went to an excursion outdoors scored higher on LCN and NR, as well as higher feelings of INS. Both variables registered positive results, which means that excursioning in Isla Del Tiburon heightened the feeling of loving and caring for Nature as explained by Perkins (2010), as well as their own relationship with nature, feeling spiritually connected to the Earth and having a notion about its care (Nisbet et al., 2009). But this we can remark Greenway (1995), who refers after a study that strolling or exercising in a natural environment contributes to the improvement in individual's functioning and attention; reduces anxiety, depression, and stress; and generates higher levels of happiness than when performing activities in urban or built places (Ulrich, 1984; Berman et al., 2008; Nisbet and Zelenski, 2011; Izenstark et al., 2021).

Data also showed that PANAS, after being separated into positive and negative affects, indicates significant differences in participants who performed an activity in a natural environment than those who did not; meaning that they felt more at ease, happy and comfortable in nature. Choe et al. (2020) in the United Kingdom demonstrated in a study ($n$ = 122) that people reported considerable rising levels of wellbeing after being exposed to a natural environment as part of a relaxation program. Findings of Watson et al. (1988) despite of mentioning the concerns and limitations that could have obstructed individuals from feeling openly happy and revitalized indicate that results were presented being related to negative aspects that diminished in the experience group like reducing emotions (e.g., anguish, guilt, aggressiveness, and irritability). In Guadeloupe, Robin et al. (2021) measured positive and negative aspects after being in a natural zone aiming to discover the emotional effects of being surrounded by a tropical environment, also an innovative setting where nature connectedness was assessed, presenting a climate with humid weather characteristics. Although they found that participants indicated negative feelings (e.g., fatigue, discomfort) after being surrounded by this climate, generating unpleasant emotions on people. According to the present study, some conditions might appear to have complicated the excursionists' mood and development during the experience on the Island. These are related to people who were not used to hiking or taking long walks and also low tolerance to high sun exposure, being tired, hungry or some other conditions.

Limitations on this study refer on at least three conditions that relate to sample size. Firstly, due to travel cost, visitor expenses must be provided limiting to cover a large group of visitors. Also, duration of the excursion (whole journey) may also skew the number of participants, therefore making it complicated for people to join such experience as they have busy days or other scheduled activities. Lastly, limited number of visitors are allowed by the reserve residents. Thus, the Island is not open to public except if visitors join a recognized tour agency or a permitted group with a prescheduled visit. This suggested the research team to consider a very selected sample.

Additional research is suggested to profound on the impact people may have from being in contact with nature. Further inquiries should focus on each person enhance, reflections, deep emotions or cognitive affections while being outdoors. Also seizing from various activities, different settings should be considerate in order to promote better and steady contact with nature as well as major findings related to the self and nature bond.

After data analysis, benefits were found on the experience group concerning the way nature is perceived and the relationship they develop creating a tighter human-nature bond and feeling part of natural world. These two aspects regain value nowadays after experiencing home confinement caused by the COVID-19 pandemic, where people are forced to live not only in total social isolation but also deprived of nature and by limiting visits to green, natural, or outdoor spaces therefore feeling the effects of these restrictions in many ways. Also, it is important to keep exploring and analyzing nature benefits and promoting people to consciously enjoy the environment and recover from the large pandemic that affected the entire world.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité de Ética en Investigación de la Universidad de Sonora. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

GG-T contributed with the conceptualization, and design of this study, acquisition of data, ran formal analysis, and organized databases. CT-F contributed by supervising this study, its methodological tasks, and data interpretation. BF-S and LP made substantial contributions by editing and revising the manuscript critically for important intellectual content. GG-T and DB-M provided the writing of the original draft. All authors contributed to manuscript revision and read and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.864836/full#supplementary-material

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# Moral-psychological mechanisms of rebound effects from a consumer-centered perspective: A conceptualization and research directions

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Rebound effects on the consumer level occur when consumers' realized greenhouse gas emission savings caused by behaviors that might be beneficial to the environment are lower than their potential greenhouse gas emission savings because the savings are offset by behavioral adjustments. While previous literature mainly studied the economic mechanisms of such rebound effects, research has largely neglected the moral-psychological mechanisms. A comprehensive conceptualization of rebound effects on the consumer level can help fill this void and stimulate more empirical research in this relevant area. To this end, the paper introduces three focal dimensions of rebound effects on the consumer level: mechanism of rebound effects, product category, and consumption context. Based on this conceptualization, and integrating assumptions from the theory of moral licensing, the theory of categorization, and the construal level theory, this paper further refines the conceptualization of the moral component as an explanatory factor for rebound effects and highlights that the moral-psychological mechanisms of indirect rebound effects (i.e., rebound effects that occur across different product categories or consumption contexts) are more complex and diverse than the economic mechanisms. The paper outlines promising directions for future studies considering the different quantification and characteristics of economic and moral currencies that explain rebound effects on the consumer level and the strategic categorization of products and consumption contexts.

KEYWORDS

**moral licensing, rebound effects, categorization, behavioral spillovers, consumption context**

## Introduction

*Imagine the company iReliefs hires two sales representatives, Oeconomica and Moralis, for organic ready-to-eat meals. The company employs Oeconomica due to her experience in her previous job as a financial controller, while it employs Moralis because her sustainability attitudes match the company's philosophy. From their first salary, both decide to buy an e-bike for private purposes to replace car rides by e-bike rides. Oeconomica calculates her savings over time through switching from car to e-bike, and spends the gained financial resources on foreign travel. Moralis concludes that switching to the e-bike is a moral deed. Since she reduced her carbon footprint, she feels liberated to act less sustainably in other consumption areas. Subsequently, Moralis will choose the meat dish over the vegetable dish in the canteen at work more often. Whereas replacing their cars with e-bikes activates different mechanisms for Moralis and Oeconomica, the consequences are similar: Greenhouse gas emission-intensive behavioral responses attenuate the potential greenhouse gas emission savings, i.e., a rebound effect on the consumer level.*

Rebound effects refer to the failed realization of potential greenhouse gas emission savings. They are a severe problem, which hinders the achievement of the goal to slow down climate change. Originated in the economic literature, macro level rebound effects refer to the gap between an aggregated economy's potential and actual overall emission savings (Gillingham et al., 2016; Santarius et al., 2018)[1], while micro rebound effects refer to the gap between potential and actual greenhouse gas emission savings of individual consumers or households (e.g., Sorrell, 2007; Chitnis et al., 2013). In this article, we focus explicitly on rebound effects on the single consumer level. These rebounds occur when consumers' realized greenhouse gas emission savings caused by behaviors that might be beneficial to the environment, such as saving of conventional energy (e.g., through technical improvements) or the abandonment of harmful consumption (e.g., meat consumption), are lower than their potential greenhouse gas emission savings because the savings are partially or fully offset or even overcompensated by behavioral adjustments that are relatively detrimental to the environment (e.g., Reimers et al., 2021). [2]

Previous studies have intensively researched the economic mechanisms that lead to rebound effects on the consumer level (e.g., Sorrell et al., 2009, 2018; Sorrell, 2012; Azevedo, 2014; Font Vivanco et al., 2018). These mechanisms are based on income and substitution effects (Chitnis and Sorrell, 2015; Gillingham et al., 2016). Moral-psychological mechanisms can, however, also stimulate rebound effects on the consumer level. However, as outlined by the few exceptions of conceptual papers that started discussing these effects (e.g., Dütschke et al., 2018, 2021; Sorrell et al., 2020; Reimers et al., 2021), these effects have thus far been largely ignored in empirical research. The concept of moral licensing (Merritt et al., 2010; Mullen and Monin, 2016) has recently emerged as a promising theoretical foundation for the moral-psychological mechanisms. Calls become louder to apply this theory to shed light on the relationship between consumers' initial moral actions and their subsequent behavioral adjustments that attenuate the potential greenhouse gas emission savings (Dütschke et al., 2018; Sorrell et al., 2020; Reimers et al., 2021). We claim that moral licensing theory can also help explain inconsistent behavioral consumption patterns across different product categories and consumption contexts. Applying moral-psychological mechanisms to explain rebound effects on the consumer level, therefore, bears the potential to account for a wide array of effects, which are beyond the realm of economic explanations. This study, therefore, develops the conceptual and theoretical foundation to stimulate research in this promising future research area.

Research on rebound effects on the consumer level distinguishes between direct and indirect rebound effects (e.g., Sorrell, 2007; Chitnis et al., 2014; Dütschke et al., 2018). Direct rebound effects describe that consumers' actual greenhouse gas emissions in one product category increase after they have performed certain greenhouse gas emission reducing behavior in that same category, while indirect rebound effects describe that consumers increase greenhouse gas emissions in another product category (Chitnis et al., 2014). In this article, we focus on the individual's subjective view, claiming that the borders across product categories are more blurred from a consumer-centered perspective. We expand the literature on categorization, which confirms that consumers apply individual perceptions of categories and that they even create categories to group objects for their purposes (e.g., Loken, 2006;

1 Macroeconomic rebound effects refer to analyzing computable general equilibrium effects, whereas microeconomic rebound effects refer to analyzing partial equilibrium effects. In this research, we focus on rebound effects on the level of the single consumers. These effects also have an impact on the whole economy. However, examining these impacts is not part of our research focus. Some research also explicitly considers meso-economic rebound effects as production-side and sector-level effects (e.g., Santarius, 2016; Santarius et al., 2016).

2 Past research has analyzed rebound effects with respect to different impact measures, such as energy, greenhouse gas emissions, or water consumption (for an overview see Reimers et al., 2021). In the context of greenhouse gas emission, some researchers also differentiate between direct and indirect emissions when analyzing indirect rebound effects (embodied emissions; e.g., Chitnis et al., 2014). We consider rebound effects in terms of greenhouse gas emissions in this research. Thereby, we do not specify whether direct or indirect emissions are involved, as our focus is not on quantifying rebound effects, but rather on explaining the underlying moral-psychological mechanisms. The conceptualization presented in this research is applicable to various impact measures. Formally, the rebound effect (R) is defined as R = (PES-AES)/PES = 1-AES/PES with PES being the potential emissions savings and AES being the actual emissions savings (Chitnis et al., 2013; Thomas and Azevedo, 2013; Reimers et al., 2021).

Loken et al., 2008). We propose that the same processes occur for consumption contexts (e.g., private vs. work contexts). These individual perceptions of product categories and consumption contexts call for research on multifaceted indirect rebound effects. To disentangle these complex mechanisms, we suggest a clear multidimensional conceptualization of rebound effects on the consumer level.

This conceptual paper makes several contributions to the literature: First, we introduce a well-structured conceptualization of rebound effects on the consumer level. We define three dimensions: mechanism of rebounds (economic or moral), product category (same or different), and consumption context (same or different). We combine these three dimensions to develop a conceptualization termed the "rebound cube," which categorizes different types of direct and indirect rebound effects on the individual level. Second, based on this new conceptualization and integrating assumptions from the theory of moral licensing, the theory of categorization, and the construal level theory, we outline promising directions for future empirical research.

The remainder of the paper is organized as follows. First, we provide the theoretical basis of our conceptualization. Next, we introduce our novel model of rebound effects on the consumer level. Finally, we outline implications for future research.

## Theoretical background

In this chapter, we explain the theoretical and conceptual foundations that are essential to our conceptualization and our later discussion. First, we disentangle basic concepts such as rebound, spillover effects, and moral licensing. Subsequently, we introduce the concept of moral licensing (e.g., Miller and Effron, 2010; Merritt et al., 2010; Mullen and Monin, 2016), which serves as a theoretical background of moral-psychological mechanisms of rebound effects on the consumer level, which will be explained more deeply in section "Economic or moral-psychological mechanisms." Afterward, we portray the theory of categorization (e.g., Barsalou, 1983; Loken et al., 2008), which helps explain consumers' subjective categorization processes of product categories and consumption contexts. We will refer to the theory of categorization in sections "Same or different product category" and "Same or different consumption context" to discuss the role of product categories and consumption context in explaining direct and indirect rebound effects. Lastly, we introduce the construal level theory (Trope and Liberman, 2003, 2010), which we will use in chapter. Directions for future research on rebound effects from a consumer-centered perspective to link the insights from the concept of moral licensing and the categorization theory to propose that indirect rebound effects occur frequently.

## Definition of rebound effects and related concepts

The literature does not consistently distinguish between the concepts of rebound effects, negative spillover effects, and moral licensing. Instead, these concepts are often described as overlapping, or they are used interchangeably (e.g., Truelove et al., 2014; Nash et al., 2017; Nilsson et al., 2017; Galizzi and Whitmarsh, 2019). Notably, relevant distinctions exist (Reimers et al., 2021).

To avoid confusion, we define rebound effects as the quantified gap between consumers' actual greenhouse gas emission savings and the emission savings that they could potentially realize using energy saving alternatives or through more sufficient consumption (Sorrell, 2007; Guerra and Sancho, 2010; Thomas and Azevedo, 2013; Chitnis et al., 2014; Dütschke et al., 2018). We use the term "rebound effect" without any assumptions about the underlying (economic or moral-psychological) mechanisms that may cause rebound effects.

Behavioral spillover effects describe that a consumer's initial behavior positively or negatively influences the probability of their subsequent behavior (Nilsson et al., 2017). In the context of morally laden behavior (i.e., pro-environmental behavior) a behavioral spillover effect indicates that one morally laden behavior influences the occurrence of another morally laden behavior. Positive spillover effects occur if the subsequent behavior is also morally laden. Negative spillover effects refer to immoral subsequent behavior (Nilsson et al., 2017; Galizzi and Whitmarsh, 2019). Positive spillovers are therefore consistent behavioral patterns from a moral standpoint, while negative spillovers are inconsistent behavioral patterns (Thøgersen, 1999; Juhl et al., 2017; Galizzi and Whitmarsh, 2019; Mai et al., 2021). Negative behavioral spillover effects can cause rebound effects. Again, we use the term "spillover effect" without implying any (economic or moral-psychological) mechanism that explains the reason for the negative relationship between two (e.g., morally laden) behaviors.

We refer to moral licensing to describe the underlying moral-psychological mechanisms of negative spillover effects, which can ultimately lead to rebound effects (Nilsson et al., 2017; Dütschke et al., 2018; Reimers et al., 2021). Other mechanisms, such as social-psychological or sociological mechanisms, where environmentally friendly behavior is influenced by standards and norms of the social environment may also lead to negative spillover effects (see Reimers et al., 2021). In this paper, we focus on moral-psychological mechanisms of rebound effects. To summarize, we use the term "rebound effects" to focus on the outcome, "spillover" to describe behavioral reactions, and "moral licensing" to describe the moral-psychological mechanisms.

## Moral licensing

The concept of moral licensing describes the phenomenon that "past good deeds can liberate individuals to engage in behaviors that are immoral, unethical, or otherwise problematic, behaviors that they would otherwise avoid for fear of feeling or appearing immoral" (Merritt et al., 2010, p. 344). Within the extensive research on moral licensing (for a meta-analytical overview, see Blanken et al., 2015), there is a consensus on two possible processes that can explain moral licensing: *moral credits* and *moral credentials* (Miller and Effron, 2010; Mullen and Monin, 2016).

According to the moral credits view, morally laden deeds, i.e., actions that can be considered morally good, create moral credits, which can be regarded as a moral currency. Individuals can, metaphorically speaking, deposit and withdraw these moral credits from their moral bank account (Miller and Effron, 2010). After having performed a morally laden deed, they can use their moral savings at a later point in time to offset a less moral deed. Notably, individuals will still interpret the immoral behavior as a moral transgression. They can, however, equalize the transgression by a former good deed. This view thus implies a fluctuation of the moral self-concept through subsequent moral and immoral behaviors (e.g., Sachdeva et al., 2009; Zhong et al., 2009; Miller and Effron, 2010). The moral credentials view assumes that individuals who have performed moral actions in the past change the way how they perceive their behavior in such a way that they will not fear being evaluated as questionable by themselves or observers—even if they actually are (Monin and Miller, 2001; Merritt et al., 2012).[3] The moral credentials view therefore proposes that specific deeds do not affect the moral self-concept (Effron and Monin, 2010; Mullen and Monin, 2016).

Previous studies have confirmed that moral licensing shapes behavior in various domains, including ethical behavior of group leaders in a working context (Wang and Chan, 2019), consumer decisions linked to morality, e.g., buying self-indulgent products or the amount of donations for charitable purposes (e.g., Khan and Dhar, 2006; Chang and Chen, 2019), food choices (e.g., Wilcox et al., 2009), company–NGO collaborations (Schlegelmilch and Simbrunner, 2019), and climate/environmental behavior (e.g., Sachdeva et al., 2009; Mazar and Zhong, 2010; Meijers et al., 2015). A number of scholars have already transferred the theory to the context of rebound effects, where the immoral action is usually accompanied by relatively high greenhouse gas emissions (e.g., Panzone et al., 2012; Harding and Rapson, 2019). Several moderators have been suggested to explain whether initial moral behaviors lead to consistent behavioral patterns or to licensing, including the level of mental construal (Mullen and Monin, 2016; Lasarov and Hoffmann, 2020). We use the concept of moral licensing which serves as a theoretical background of moral-psychological mechanisms of rebound effects on the consumer level, which we explain more deeply in section "Economic or moral-psychological mechanisms."

3 Recent research has coined the term social moral licensing to consider the influences of the social environment on moral licensing (Lasarov and Hoffmann, 2020). In this research, we focus on individual moral licensing.

## Theory of categorization

Categorization describes the process when individuals use categorical representations "to assign a particular product or service to a consumer category, so that they can understand and draw inferences about it" (Loken et al., 2008, p. 133). Consumers use categories to group related objects (Loken et al., 2008). Early research on categorization theory suggests that consumers can make use of common taxonomic categories, such as bikes and cars, but they may also create categories that match their personal goals (Barsalou, 1983, 1985). For example, when a consumer plans a vacation, he or she may categorize vacation options either along the categories types of transportation or places to go (Barsalou, 1985, p. 632).

Goal-derived categories allow cross-categorization of objects. The goal-derived categories can consist of several previously established categories or specific subgroups of categories (Barsalou, 1983, 1985), and they can include categories that do not necessarily share the same characteristics (Ratneshwar et al., 2001). For example, the places to go may include beaches, pyramids, four-star hotels, and Australia. *Ad hoc* categories are goal-derived categories that individuals actively construct in a particular situation to achieve novel goals, for example, finding an alternative mobility concept to go to work when the car is broken. *Ad hoc* categories are therefore not based on well-established category representations in memory like common taxonomic categories or goal-derived categories that are more frequently used (Barsalou, 1983, 1985, 1991).

Research on consumer categories concludes that consumers' interaction with various products and with a steadily changing environment requires categorical representations to be stable and flexible (Loken, 2006; Loken et al., 2008). According to Loken (2006, p. 458) "consumers need to have stable representations of objects and events in memory that can be used for interpreting" and "evaluating object and also require flexibility and the ability to adapt to changes in the environment." Accordingly, to draw inferences about objects, individuals use representations of product categories that are stable over time and across different product categories (Loken et al., 2008). Still, depending on the usage context and personal goals, category boundaries and the assignment of objects to categories be also malleable and flexible (Ratneshwar and Shocker, 1991). We will refer to the theory of categorization to discuss how consumers can individually define the product

categories (see section "Same or different product category") and consumption contexts (see section "Same or different consumption context") in the context of pro-environmental behavior that may lead to rebound effects.

## Construal level theory

The level of construal has been suggested as one moral licensing moderator (Mullen and Monin, 2016; Lasarov and Hoffmann, 2020). We will now briefly introduce the construal level theory (CLT; Trope and Liberman, 2003, 2010). While we need the concept of moral licensing and the categorization theory to develop the rebound cube, we will use the CLT to derive further propositions. Hence, in section "Directions for future research on rebound effects from a consumer-centered perspective," we will combine the CLT with the concept of moral licensing and the categorization theory to explain how consumers can intentionally define the construal level to strategically define product categories and consumption contexts across which moral-psychological rebound effects occur.

The construal level theory (Trope and Liberman, 2003, 2010) proposes a relationship between a consumer's psychological distance to an object or event and the extent to which the consumer's thinking about the object or event is abstract or concrete. The level of construal refers to the level of abstraction (low vs. high abstraction level) and is thus related to how narrow (concrete) or broad (abstract) objects are categorized (Liberman et al., 2002). Psychological distance is defined as the "subjective experience that something is close or far away from the self, here, and now" (Trope and Liberman, 2010, p. 1). For example, participants in a study by Liberman et al. (2002) were asked to imagine different leisure activities (e.g., camping trip; moving out) that would take place in a year (distant) or next weekend (proximate). They were then asked to group different objects (e.g., brush, tent, matches; desk, VCR, pets) into the same set of objects. Individuals who were asked to imagine the activity in 1 year created fewer and thus broader categories (Liberman et al., 2002). According to the construal level theory, consumers can only directly experience what is in the immediate environment. Psychological distances emerge in temporal, spatial, social, and hypothetical dimensions. Regarding the interplay between psychological (temporal distance) and the level of construal and illustrated in the study by Liberman et al. (2002), for example, CLT suggests that individuals are more inclined to classify objects into abstract categories for situations in the distant future than for situations in the proximate future.

Whereas low-level construals are more related to subgoals and explain how an action is supposed to be done, high-level construals are more general and thus explain the reasons or superordinate goal for a performed action (Mullen and Monin, 2016). Accordingly, closer distances lead to more concrete thoughts on the object (low-level construal), thus focusing on the subordinate, concrete level including detailed information about an object. Higher distances lead to more abstract thinking about the object (high-level construal), focusing on the superordinate, abstract level, and removing information that is unnecessary according to the goal that the mental representation is chosen for (Trope and Liberman, 2010).

# A new conceptual foundation for rebound effects on the consumer level

We now introduce a new conceptual foundation for direct and indirect rebound effects on the consumer level, which is structured along three continuous dimensions, with the first ranging from economic to moral-psychological mechanisms of rebounds, the second ranging from the same to a different product category, and the third ranging from the same to different consumption context. For the sake of simplicity, we focus in this article on the anchors of these dimensions (economic vs. moral-psychological mechanisms, same vs. different product category, same vs. different consumption context). However, all three dimensions are continuous (from economic via mixed to moral-psychological mechanisms, from the same product category via decreasing similarity to completely unrelated product categories, from the perception of a highly similar consumption context to very distant consumption contexts). Moreover, we explicitly distinguish between the dimensions of product category and consumption context as both of these external factors, object (= product category) and the setting (= consumption context) can influence consumption behavior (Belk, 1975). Remarkably, we will later show that the manner how consumers categorize product categories and consumption contexts follow the same logic and we will use the theory of categorization to explain the perceived similarities for both dimensions (Loken et al., 2008). As we later demonstrate consumers could even (strategically) define product categories and consumption contexts as similar or different. Therefore, the subjective perspective of consumers can create a wide spectrum of indirect rebound effects via moral licensing.

## Economic or moral-psychological mechanisms

Rebound effects can be stimulated by *economic mechanisms* that are based on income effects and/or substitution effects (Chitnis and Sorrell, 2015; Gillingham et al., 2016). When

consumers save greenhouse gas emissions by switching to a more energy-efficient consumption alternative, they often also save money. Income effects occur when the cost savings due to the lower energy consumption are re-invested in consumption. If this consumption is associated with additional greenhouse gas emissions, a rebound effect occurs (Chitnis and Sorrell, 2015).

Based on the concept of moral licensing, rebound effects can also be stimulated by *moral-psychological mechanisms* (e.g., Santarius et al., 2016; Dütschke et al., 2018, 2021; Santarius and Soland, 2018; Sorrell et al., 2020; Reimers et al., 2021). Consumers might believe that they have done something good for the environment if they switch to a consumption alternative involving less greenhouse gas emissions. If consumers, for example, switch to an energy-efficient e-bike vs. a car with a combustion engine, they may gain moral credits that liberate them to act less sustainably in a subsequent act of consumption.

Economic and moral-psychological mechanisms may occur independently of each other and they may also overlap. The simultaneous occurrence of both mechanisms may increase the rebound effects, compared to rebounds that are stimulated by a single (moral-psychological or economic) mechanism. However, even when a sustainable and greenhouse gas emission saving action is not associated with financial savings (e.g., buying more expensive organic food instead of conventional food), moral-psychological rebound effects may occur.

## Same or different product category

The term product relates to all tangible products and intangible products (services). The purchase of a product or the use of a service may involve monetary or non-monetary (e.g., time) expenditures. A product category refers to a group of products that share similar benefits.

Rebound effects can occur within the *same product category* (direct rebound effects) or between *different product categories* (indirect rebound effects; Chitnis et al., 2014). The study of Tiefenbeck et al. (2013) provides an example of negative spillover effects across different product categories. The authors found that providing consumers with feedback about the decrease of their water consumption causes an increase of consumption in another product category, namely electricity usage.

However, research highlights that consumers individually define product categories (Alba and Hutchinson, 1987; Cohen and Basu, 1987; Loken et al., 2008; Chowdhury and Feisal, 2020). They may even individually define specific product categories to serve a particular goal (e.g., Loken, 2006; Loken et al., 2008). Consequently, consumers may have their own perception about whether two products belong to the same product category or to different categories. For example, one consumer may ascribe using an e-bike and using an airplane for a holiday trip as two different categories (riding vs. flying), whereas another person may ascribe both to the same category (mobility concept). Along the same lines, one person may consider that meat-based dishes and plant-based dishes belong to the same category (food), whereas another person ascribes them to different categories (meat vs. vegetarian food). So far, the literature is ambiguous about whether moral licensing or spillover effects are more likely to occur in the same or different domains of actions. The meta-analytic review by Blanken et al. (2015) could not find any difference in the size of moral licensing effects in the same and different domain of actions. However, this research does not specifically focus moral licensing in the context of environmentally friendly behavior, but rather in different fields of action (e.g., donations, heating, volunteering). Thøgersen and Crompton (2009) conclude that positive spillover effects in the context of pro-environmental behavior become less likely for dissimilar behaviors. In line with that, the meta-analysis by Maki et al. (2019) found positive spillover to be less likely and negative spillover effects to be more likely for low similarity of two pro-environmental behaviors.

Particularly for the moral-psychological mechanisms of rebound effects, it is relevant to understand whether consumers ascribe two products to the same or to different categories, as the moral-psychological processes that enable subsequent licensing behavior may differ for within-category and cross-category constellations. For example, it may be subjectively easier to justify a cross-domain effect than a within-domain effect, because two actions in the same domain are more comparable and immoral deeds can therefore completely neutralize the former moral deeds in the same category. The morality of two purchases or usages in different product categories is more difficult to compare, which allows for more subjective interpretation and flexibility, which may ultimately lead to more intensive processes of moral licensing.

## Same or different consumption context

While there is no general accepted definition of consumption contexts, we refer to the literature on spillover effects to define consumption context as the setting in which a product or service is used (e.g., during holiday, work or, leisure time; Nilsson et al., 2017). Past research has demonstrated that contextual and situational factors influence consumer behavior (Belk, 1975) and moral behavior (Jones and Kavanagh, 1996; Tsang, 2002). In particular, these factors influence sustainable consumption behavior (Schultz et al., 1995; Simpson and Radford, 2014; Steg et al., 2014).

Rebound effects can occur in the same consumption context. For example, after a consumer has potentially saved greenhouse gas emissions in a certain consumption context he or she may later increase greenhouse gas emissions in the same. For example, consumers using the train instead of a private car (product category) for a private holiday trip (private consumption context) may later use the plane instead of a

private car (product category) in a later private holiday trip (private consumption context).

A different consumption context means that a consumer's potential greenhouse gas emission savings in one consumption context are attenuated by greenhouse gas emissions produced in another consumption context. For example, consumers using the train (product category) for a business trip (work context) may later use the plane (product category) for a private holiday trip more often (private context) which may be stimulated by moral credits gained.

Previous studies on behavioral spillover effects have already considered the role of consumption contexts with regard to two subsequent climate-relevant actions (e.g., Barr et al., 2010; Littleford et al., 2014). As stated in section "Same or different product category," past research suggests that positive spillover effects are more likely for highly similar pro-environmental behaviors and negative spillover effects are more likely in less similar pro environmental behaviors (Thøgersen and Crompton, 2009; Maki et al., 2019). This literature however, mainly focuses on classes of pro-environmental behaviors (or product categories) and therefore do not take into account the consumption contexts. Even though previous studies have highlighted the importance to consider different contexts when analyzing behavioral spillover effects (e.g., Nilsson et al., 2017), the role of consumption contexts as neither been sufficiently discussed nor empirically tested with regard to rebound effects.

Referring to the theory of categorization (Loken et al., 2008), individuals may categorize their everyday consumption behavior into different consumption contexts, i.e., the context in which a product or service is used. The consumer's perception determines the boundaries between different consumption contexts and consumers may even define these boundaries in favor of their personal goals. For example, one consumer may assign the two actions of riding a bike in her or his leisure time and riding a bike for business trips to the same consumption context (e.g., any consumption context). Another consumer may allocate the two actions to different consumption contexts (private context vs. work context). Again, this distinction is particularly relevant for explaining whether consumers use an initial act as a license for subsequent actions that lead to rebound effects.

## Literature about rebound effects on the consumer level

Empirical research about rebound effects on the consumer level has thus far mainly focused on economic rebound mechanisms, including direct and indirect rebound effects (for an overview, see, e.g., Sorrell et al., 2009, 2018; Sorrell, 2012; Azevedo, 2014; Font Vivanco et al., 2018). These studies analyze data based on consumer expenditure surveys or aggregated consumer demand statistics (Reimers et al., 2021), and thus they do not include specific information on single consumption contexts. Also, there is a number of empirical literature on spillover effects in the context of pro-environmental or climate-relevant behavior, mainly not considering the underlying psychological mechanisms (for a review see Maki et al., 2019; Geiger et al., 2021). Empirical studies on moral licensing in the context of pro-environmental or climate-relevant behavior are scarce (Phipps et al., 2013; Dütschke et al., 2018, 2021; Reimers et al., 2021). The literature on moral licensing offers fewer studies where the both sequential (im)moral actions are connected to consumption decisions (e.g., Catlin and Wang, 2013; Meijers et al., 2019; Burger et al., 2022) and thus allow to differentiate between same and different categories and contexts (for an extensive literature review, see Sorrell et al., 2020; Reimers et al., 2021). However, different consumption contexts have thus far rather been considered in the literature on behavioral spillover. With our novel conceptualization, we consider for the first time simultaneously different mechanisms, product categories and consumption contexts in rebound research. **Table 1** illustrates how previous research on different research streams on economic rebound effects, moral licensing and spillover effects can exemplarily be classified along the three dimensions of the rebound cube.

## Rebound cube

The three bipolar dimensions of mechanisms, product categories, and consumption contexts span up a three-dimensional model of rebound effects, which we term the rebound cube (depicted in **Figure 1**). This model builds the bases to describe different processes that lead to direct and indirect rebound effects on the consumer level.

This conceptualization outlines several novel and relevant aspects. First, there is not just a simple distinction between direct and indirect rebounds: Based on the combination of the three dimensions, we identify eight different types of rebound effects on the consumer level. Notably, while we use the anchors of the three dimensions to distinguish eight parts of the cube for the sake of simplicity, all dimensions are continuous. This is visualized in the figure by increasing and decreasing gray triangles. Rebound effects can be based on moral-psychological and/or economic mechanisms, and occur as direct, cross-category, cross-context, or cross-category and cross-context rebound effects. Second, these types of rebound effects are less well defined than initially thought. Given that consumers can individually and even strategically define product categories and consumption contexts, studies on rebound effects on the consumer level need to consider the variations of the individual perceptions. In the following, we will suggest directions for future research to disentangle these processes.

To systematically describe the eight different types of rebound effects, we refer to the illustrative introductory example. Imagine that the company iReliefs intends to involve

TABLE 1 Overview of recent research that contributes to rebound cube.

| Research stream | Article | Rebound cube dimension | | | Main findings that contribute to the rebound cube |
|---|---|---|---|---|---|
| | | Mechanism | Category | Context | |
| *Economic Rebound Effects* | Davis, 2008 | ○ | = | nc | Direct economic rebound effects from the usage of highly efficient washing machines: Households increased clothes washing after receiving a new washer. |
| | Buhl and Acosta, 2016 | ○ | ≠ | nc | Resource sufficiency based indirect rebound effects in the domains of food, housing, and transport, from lowering room temperature, avoiding short car trips, and reducing food waste. |
| | Chen et al., 2019 | ○ | = , ≠ | nc | Direct and indirect rebound effects from transport: Efficiency improvements for urban passenger transport lead to an increased demand for all commodities. |
| *Moral Licensing* | Catlin and Wang, 2013 | ● | = | = | Moral licensing effects within the same product category and consumption context: The possibility to use a recycling bin subsequently increased the amount of paper and paper towel consumption. |
| | Meijers et al., 2019 | ● | ≠ | = | Moral licensing effects across different product categories in the same consumption context for people with low environmental identity: For example, the purchase of "green" sneakers lower behavioral intentions to perform different environmental activities (e.g., willingness to pay more for electricity to support clean air). |
| | Noblet and McCoy, 2018 | ● | ≠ | = | Moral licensing effects across different consumption categories in the same consumption context: People who stated that they formerly had performed sustainable activities were less likely to support a public policy investment in energy efficiency/renewable energy. These effects are mediated by an internal environmental motivation. |
| *Behavioral Spillover Effects* | Tiefenbeck et al., 2013 | ● | = , ≠ | = | Negative spillover cross-category effects caused by environmental feedback in the same context: Individuals decreased water consumption but at the same time increased electricity usage. |
| | Barr et al., 2010 | nc | = , ≠ | ≠ | Different consumption contexts and lifestyle groups need to be considered when analyzing pro-environmental consumption behavior. Certain people behave less environmental friendly when on holiday than when at home. |
| | Littleford et al., 2014 | nc | = , ≠ | =, ≠ | The consumption context (home vs. work) is an important factor influencing energy use behavior. However, this research could not support spillover effectsacross contexts. |

Mechanism: ●, moral-psychological; ○, economic; Category: =, same; ≠, different; Context: =, same; ≠, different; nc, not considered. We selected examples of studies from previous research that can be clearly categorized according to the rebound-cubes dimensions. For a literature review, please consult section "Literature about rebound effects on the consumer level".

its employees more in the company's sustainability strategy. Sales representatives are asked to use their conventional bikes or e-bikes to travel to appointments at different locations (e.g., supermarkets, train stations, newspaper shops). To replace private car rides, both Oeconomica and Moralis bought an e-bike from their first salary, thereby setting the stage to save greenhouse gas emissions. However, instead of realizing these emission savings, both adjust their consumption behaviors. While economic mechanisms explain Oeconomica's behavioral adjustments, moral-psychological mechanisms explain Moralis' behavioral adjustments. The effects could potentially occur in the same product category (mobility concept) or in different product categories (e.g., food), and in the same consumption context (private setting) or in different consumption contexts (work setting). **Table 2** systematically illustrates all eight potential rebound effects based on the new conceptualization. A moral-based direct rebound effect (rebound-type 1), for example, may occur, because Moralis had formerly tried to reduce the usage of the car with combustion engines by using a conventional bike (mobility concept) for shopping trips in her leisure time (private setting). However, she now spends the moral credits to use the e-bike (mobility concept) for every possible shopping trip (private setting).

## Directions for future research on rebound effects from a consumer-centered perspective

Relying on the rebound cube as a conceptual basis, we propose directions that hopefully stimulate future research on the moral psychology of rebound effects. As we will show in the following, the category and context effects are highly relevant for the moral-psychological mechanisms, as these effects open up a large spectrum of possible licensing effects and thus various indirect rebound effects from a consumer centered perspective. To disentangle these effects, we combine the key elements of moral licensing theory, the theory of categorization, and the construal level theory with the three dimensions of the rebound cube to suggest promising

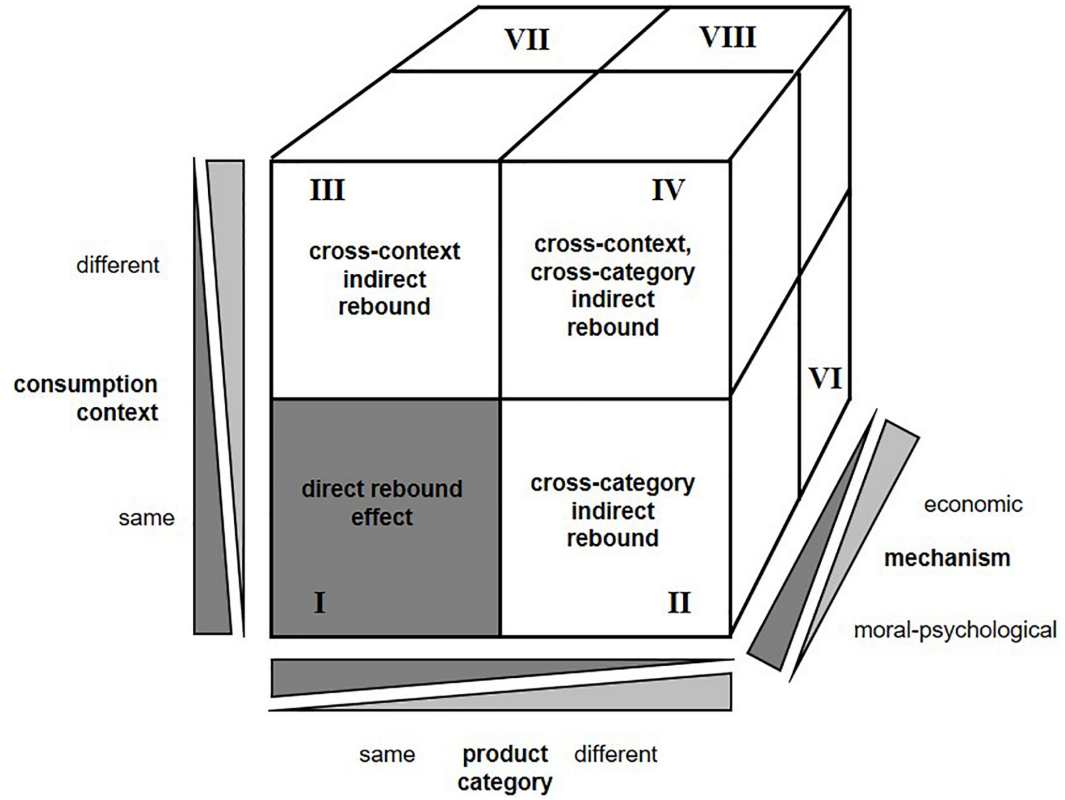


FIGURE 1
Rebound cube.

avenues for future research. We call for research on the different quantification of economic and moral "currencies" that explain rebound effects on the consumer level, on the different characteristics of economic and moral currencies, on the strategic categorization of products, and on the strategic categorization of consumption contexts.

We now introduce three research avenues each derived from the three dimensions of the rebound cube: mechanism of rebounds (economic or moral-psychological), product category (same or different), and consumption context (same or different).

## Research avenue on rebound-cubes dimension: Economic or moral-psychological mechanisms

**Avenue 1:** *While monetary induced (in)direct rebound effects are associated with real emission savings, (im)moral acts cannot equally be translated into emission savings.*

*Different quantification of economic and moral currencies.* Both economic and moral-psychological mechanisms of rebound effects are based on a "currency." The economic currency is easy to quantify and the more money a consumer saves in one consumption action, the more he or she can potentially spend in another consumption action. For example, a consumer may save 50 USD monthly by switching from a car to an e-bike, and he or she can spend this money on holiday trips. Economic rebound effects based on income and substitution effects are therefore well researched (for an overview on direct and indirect rebound research, see, e.g., Sorrell et al., 2009, 2012; Azevedo, 2014; Font Vivanco et al., 2018; Sorrell et al., 2018).

The currency of morally laden behavior (moral credits) is fuzzier and harder to quantify. Past research shows that consumers link environmentally friendly behavior to morality (e.g., Mazar and Zhong, 2010). However, different consumers will evaluate the moral impact of the same morally laden behavior differently due to individual factors (e.g., involvement, knowledge) and contextual factors (e.g., private, public consumption). Even if consumers are informed about the greenhouse gas emissions caused by their behavior, they may not understand the implications of this measure (White et al., 2019).

Factors that affect the subjective evaluation include, for example, that consumers have an inadequate understanding of

TABLE 2 Examples of rebounds according to the rebound cube.

| | Rebound-type | Scenario | Configuration | | | Example |
|---|---|---|---|---|---|---|
| No. | Name | Mechanism | Mechanism | Category | Context | Category and context of rebound |
| I | Moral-based direct rebound | | • | = | = | While she had formerly tried to reduce the usage of the car with combustion engines (e.g., riding a conventional instead of using the car for shopping trips in her leisure time), she now spends the moral credits to use the e-bike for every possible shopping trip. |
| II | Moral-based cross-context indirect rebound | | • | = | ≠ | While she had formerly used her conventional bike for all routes at work, she spends the moral credits that she had earned in her leisure time for using the new e-bike also for business trips at work. |
| III | Moral-based cross-category indirect rebound | By switching to the more energy-efficient e-bike compared to a car with a combustion engine *Moralis* earns moral credits as she does something good for the environment. She can spend the moral credits in the same or different category and context. | • | ≠ | = | Now that she uses a more energy-efficient mobility concept, she allows herself to consume less sustainably in different product category. She spends the moral credits for consuming meat dishes at home more often. |
| IV | Moral-based cross-category, cross-context indirect rebound | | • | ≠ | ≠ | Now that she uses a more energy-efficient mobility concept for private purposes, she allows herself to consume less sustainably in a different product category at work. She spends the moral credits for choosing the meat dish over the vegetable dish in the canteen at work more often. |
| V | Economic-based direct rebound | | ○ | = | = | While she had formerly tried to reduce the usage of the car with combustion engines (e.g., riding a conventional bike instead using the car for shopping trips), she now spends the additional financial resources to use e-bike for every possible shopping trip. |
| VI | Economic-based cross-context indirect rebound | | ○ | = | ≠ | While she had formerly used her conventional bike for all routes at work, she spends the additional financial resources that she had earned in her leisure time for using the new e-bike also for business trips at work. |
| VII | Economic-based cross-category indirect rebound | By switching to the more energy-efficient e-bike compared to a car with a combustion engine *Oeconomica* earns additional financial resources, e.g., due to income effects. She can spend the financial resources in the same or different category and context. | ○ | ≠ | = | Now that she uses a more energy-efficient mobility concept, she saves money that she can spend in a different product category. She spends the additional financial resources for consuming meat dishes at home more often. |
| VIII | Economic-based cross-category, cross-context indirect rebound | | ○ | ≠ | ≠ | Now that she uses a more energy-efficient mobility concept for private purposes, she saves money that she can spend in a different product category at work. She spends the additional financial resources for choosing the meat dish over the vegetable dish in the canteen at work more often. |

Mechanism: •, moral-psychological; ○, economic; Category: =, same; ≠, different; Context: =, same; ≠, different. Examples do not refer to different perceptions of categories and contexts.

the magnitude of their resource consumption (Beal et al., 2013; Grinstein et al., 2018) or the magnitude of the environmental consequences of their consumption; therefore, they either overestimate or underestimate the extent to which different behaviors affect the environment (Attari et al., 2010). Furthermore, due to self-serving biases, consumers may

overvalue the morality of their actions and undervalue the severity of their moral transgression. Consumers may thus also strategically overvalue a reduction in one category (e.g., using a bike instead of the car to travel to work once a month) to gain a higher license to justify subsequent higher greenhouse gas emissions in another category (e.g., choosing meat-based dishes in the canteen more often). For example, while Consumer A considers switching to an e-bike as a strong reduction of her carbon footprint, Consumer B does not foresee many merits for the environment.

Since previous research has quantified rebound effects based on economic units for products or services that can be clearly connected to particular measure, such as energy use or greenhouse gas emission (e.g., Chitnis and Sorrell, 2015; Gillingham et al., 2016), the starting point for future research on moral-psychological rebound effects should be a clearer understanding of subjective evaluations of moral deeds and the individual estimation of the environmental impact of moral deeds. As the literature on slacktivism shows, consumers may strategically apply even minor moral deeds to license larger transgressions (Skoric, 2012; Soyer et al., 2013). Recent research offers first approaches to connect sequential behaviors with a concrete measurable environmental consequence based on experimental studies. For example, a study by Tiefenbeck et al. (2013) shows that individuals who decreased water consumption at the same time increased electricity usage. These studies are therefore potentially suitable to quantify the magnitude of moral-psychological rebound effects based on a uniform measure, such as greenhouse gas emissions. Other studies capture consumers' individual estimations of environmental consequences based on survey studies (Grinstein et al., 2018). Future research may use these approaches to combine moral credits with hard data on concrete measures in terms of environmental impacts, such as emission savings and at the same time captures individual's perceptions of these consequences and the intrapersonal variations. In addition to more traditional moral licensing and spillover studies, research on technical solutions to measure consumers' greenhouse gas emissions should also be considered. For example, carbon footprint tracking apps allow to capture and calculate the greenhouse gas emissions of consumption across different categories (Hoffmann et al., 2022). A pre-interview or survey of the app users would provide a solution to compare the concrete calculable emissions with consumers' subjective perception of the emissions.

### Different characteristics of economic and moral currencies

Economic transactions are linked to a fixed extrinsic value. Disregarding fluctuations, for example, when it comes to inflation or investment income, financial resources remain stable in the economic bank account until they are spent. Furthermore, consumers cannot invest the same saved money twice. By contrast, a single moral action can be used as moral licensing for multiple subsequent immoral actions. For example, consumers can rely on the same past moral deed on many different occasions for different product categories and consumption contexts. Besides, the empirical research showed that moral licensing mechanisms are not stable across a series of sequential behaviors; instead, they converge to an internal moral equilibrium in the long term (Barque-Duran et al., 2016). Referring to construal level theory, recent moral behavior evokes moral licensing, whereas temporally distant moral behavior leads to consistency (Conway and Peetz, 2012). These effects should be explored in future research on moral-psychological rebound effects. Multiple usage of the same unit of the moral currency is particularly possible across different product categories and consumption contexts.

As we will demonstrate below, the moral-psychological or economic mechanisms involved in consumer decision-making may affect in different ways how consumers (strategically) interpret whether products belong to the same or different product categories. We will also show how these mechanisms differently affect how consumers' (strategically) interpret whether different consumption decisions are made in the same or in different consumption contexts.

## Research avenue on rebound-cubes dimension: Same or different product category

**Avenue 2:** *Consumers subjectively (and even strategically) interpret whether products belong to the same or to different product categories.*

*(Strategic) categorization of products based on moral-psychological and economic mechanisms.* Referring to section "Theory of categorization," research on categorization suggests that individual goals and situational factors shape how individuals categorize objects and situations (Loken, 2006; Loken et al., 2008). Self-regulation mechanisms often involve goal hierarchies, i.e., decomposing a superordinate goal into many subgoals (Fishbach et al., 2006). For example, a consumer can have a superordinate goal to reduce the greenhouse gas emissions resulting from his or her consumption. The consumer might also decompose this superordinate goal into many more concrete subgoals, such as reducing greenhouse gas emissions in the household, mobility, etc. As stated in section "Construal level theory," the level of construal has been suggested as a critical moderator of moral licensing mechanism (Mullen and Monin, 2016; Lasarov and Hoffmann, 2020). Accordingly, whether consumers focus on abstract goals or concrete goals

influences if they feel morally licensed or not in a subsequent situation (Trope and Liberman, 2010; Mullen and Monin, 2016).

Focusing on achieving one concrete goal provides consumers with a moral license, whereas consumption in other goal relevant categories may be considered as substitutes (Fishbach et al., 2006). The question as to whether two consumption actions fall within the same product category or in different product categories can influence whether consumers interpret a certain action as a moral license. Past research on moral licensing indicates a strategic interconnection between sequential actions (Merritt et al., 2012; Lasarov and Hoffmann, 2020). For example, consumers may strategically rely on anticipated moral actions, to justify their present moral transgressions (Cascio and Plant, 2015; Lasarov and Hoffmann, 2020).

Consequently, the consumers may strategically categorize products into the same or different categories based on moral-psychological considerations. For example, a consumer who usually interprets riding a bike and driving a car as belonging to the same category (mobility), may strategically ascribe the two actions to different categories after reducing emissions of the category driving (e.g., the substitution of shopping trips by car with shopping trips by bike) to justify higher emissions of the other category (e.g., driving the e-bike more often).

Consumers may also strategically categorize product categories based on economic mechanisms. For example, the literature on mental accounting suggests that consumers use mental accounts to organize their finances for different consumption categories (e.g., Thaler, 1985, 1999). However, the strategic categorization of product categories purely based on economic mechanisms may occur due to other reasons that do not take into account the environmental consequences of the individual consumer decisions. For example, consumers may decide to construe different product categories in order to allow themselves additional spending in one product category due to monetary savings in another product category.

### Strategic categorization of product category based on consumption contexts

In the context of rebound effects from a consumer-centered perspective, the strategic categorization of product categories may occur independently or dependent on the consumption contexts involved. Strategic product categorization may occur independently of the consumption context. In this case, it doesn't matter whether consumers perceive two actions as belonging to the same context or whether they do not deliberately distinguish between different contexts at all.

The strategic product categorization may also interact with the individual consumption context. Since consumers can have perceptions of different consumption contexts, they can strategically categorize products depending on such contexts. For example, consumers who differentiate between work and private contexts, may strategically categorize the product categories related to their actions differently, as in the private context they are more free and flexible in their choices than in the work context. Consumers who may save greenhouse gas emissions in one product category due to the firms' sustainability strategy (e.g., transportation type), can therefore either use the same product category in the private context to categorize their subsequent behavior (cross-context indirect rebound effect) or they may strategically categorize their behavior in the private context in more detailed categories, such as using the car, bus or train (cross-context, cross-category indirect rebound effects) to more easily justify the moral transgression.

Previous research on rebound effects has not considered these intrapersonal variations in the perception of product categories. Integrating this moral-psychological lens sets the stage to explore rebound effects that occur due to the strategic categorization of products. Notably, this more consumer-centered perspective implies that consumers can (strategically) reinterpret rebound effects that were previously considered direct rebounds, as indirect rebounds.

## Research avenue on rebound-cubes dimension: Same or different consumption context

**Avenue 3:** *Consumers subjectively (and even strategically) interpret whether different consumption choices are settled within the same or in different consumption contexts.*

*(Strategic) categorization of consumption contexts based on economic and moral-psychological mechanism.* Similar to the discussed (strategic) categorization of products, consumers might (strategically) decompose and categorize their consumption into different sub-contexts. To achieve the goal of reducing greenhouse gas emissions from personal consumption, consumers may derive different consumption contexts, such as reducing greenhouse gas emissions in the domain of mobility in the private, work, or social context. Consumers may strategically interpret whether different consumption choices are settled within the same or in different consumption contexts based on moral-psychological considerations. Different consumption contexts (work, leisure, sports, vacation, etc.) also determine consumers' social environment (e.g., co-workers, family, friends) and thus also the consumers' different social roles in these contexts. These roles in turn define different social norms and obligations for the consumers. Different social roles may therefore influence how and why consumers strategically shape different consumption contexts based on

moral-psychological considerations. Consider a consumer who usually interprets riding an e-bike as belonging to the category mobility, independently of whether she uses the e-bike in a private context or in a work context. She may thus strategically assign riding an e-bike at work (work context) and riding it for private purposes (private context) to different contexts to justify higher emissions of riding at the workplace (e.g., using an e-bike instead of using a conventional bike) after reducing emissions in free time (e.g., using an e-bike instead of a car for shopping trips). For example, the because social role of a service-oriented worker requires faster and more reliable modes of transportation in the work context.

Consumers may also strategically categorize consumption contexts based on economic mechanisms. However, this strategic categorization of consumption contexts purely based on economic mechanisms may occur due to other reasons that do not take into account the environmental consequences of the individual consumer decisions. For example, individuals might decide to construe different consumption contexts in order to allow themselves additional spending in one consumption context due to monetary savings in another consumption context.

### Strategic categorization of consumption contexts based on product categories

Whereas it is very unlikely, that consumers completely refrain from categorizing their daily objects into product categories, consumption contexts are more individually and flexibly construed. On one hand, consumers may construe strategically different consumption contexts independently from the product categories involved in their consumption decisions. For example, consumers may in general behave differently in work and private contexts independently from the specific pro-environmental actions, one reason being that they follow different norms and obligation in their social environment (e.g., family, leisure, sports, vacation). However, more likely, strategic categorization of consumption contexts may interact with the different product categories involved. Therefore, in the context of rebound effects from a consumer-centered perspective, the strategic categorization of consumption contexts may mainly occur based on former product considerations. For example, consumers who may save emissions in one product category may strategically construe different consumption context to justify transgression in the same product category (cross-context indirect rebound effect) or in another product category (cross-context, cross-category indirect rebound effects).

Similar to the discussion of product categories, adding a psychological perspective on consumption contexts can stimulate future research on moral-psychological rebound effects. For example, individuals could interpret even those rebound effects as indirect, which a third person would classify as direct.

## Conclusion

A deep understanding of rebound effects is essential to mitigate undesirable consequences of sustainable consumption and thus to promote the achievement of climate protection goals.

Rebound effects on the consumer level are thus far underconceptualized because past research has mainly considered the economic mechanisms that lead to rebound effects on the consumer level (see, e.g., Sorrell et al., 2009, 2018; Sorrell, 2012; Azevedo, 2014; Font Vivanco et al., 2018). The moral-psychological mechanisms that lead to rebound effects have, however, thus far not been sufficiently discussed in rebound research (e.g., Dütschke et al., 2018, 2021; Sorrell et al., 2020; Reimers et al., 2021). This research further refines the conceptualization of the moral component as an explanatory factor for rebound effects and advances knowledge on rebound effects on the consumer level by proposing a novel conceptualizing including three dimensions: the mechanism (economic vs. moral-psychological mechanisms of rebounds), the product category (same product category vs. different product categories), and the consumption context (same vs. different context). Whereas previous research simply distinguishes between direct and indirect effects, our conceptualization shows that indirect rebound effects are more diverse than previously suggested: They can be economic based and/or moral-psychological based, and could potentially occur in the same category or in different categories, and in the same context or in different contexts. Based on this novel conceptualization, we take a more consumer-centered perspective to show that the category and context effects are of particular relevance for the moral-psychological mechanisms, as they open up wide-ranging possible licensing effects. Our research thus contributes to a deeper understanding of indirect rebound effects, which have been less considered than direct rebound effects in the literature (Reimers et al., 2021).

We also specified numerous research areas that are presently underdeveloped. More research is needed to expand our understanding of subjective evaluations of moral deeds, and the differences in the characteristics of economic and moral currencies that explain rebound effects on the consumer level. Furthermore, we showed that future studies should take into account consumers' (strategic) categorization of products and consumption contexts. This more consumer-centered perspective implies that rebound effects previously considered direct rebounds can also be interpreted as indirect rebounds. With regard to measures against rebound effects, our conceptualization can also offer several new insights. Research, practitioners, and policy makers should consider this novel understanding of indirect rebounds to develop effective intervention strategies.

## Author contributions

HR, WL, and SH: conceptualization and writing—review and editing and original draft preparation. HR and SH: visualization and project administration. SH: supervision. WL and SH: funding acquisition. All authors read and agreed to the published version of the manuscript.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Publisher's note



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# How schools can aid children's resilience in disaster settings: The contribution of place attachment, sense of place and social representations theories

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Disasters incurred by natural hazards affect young people most. Schools play a vital role in safeguarding the wellbeing of their pupils. Consideration of schools' psychosocial influence on children may be vital to resilience-building efforts in disaster-vulnerable settings. This paper presents an evidence-based conceptualization of how schools are psychosocially meaningful for children and youth in disaster settings. Drawing on Social Representations and Place Attachment Theories, we explore the nature of group-based meaning-making practices and the meanings that emerge concerning school environments in disaster settings. We contribute a novel understanding of how schools may mitigate psychosocial risk for young people by considering how schools are conceptualised at four levels: (1) as physical environment, (2) as social arena, (3) as a place with individual and (4) group-based significance. In each of these domains schools can foster disaster resilience in young people. This paper highlights the evidence concerning the functions of schools beyond their capacity as educational institutions, critically considering their social and physical functions in their communities. This evidence can inform stakeholders involved in disaster resilience building.

KEYWORDS

**resilience, children, schools, disaster, place attachment, social representations, sense of place, risk management**

## Introduction

Children are uniquely vulnerable to the negative consequences of disasters, in part due to their dependence on adults and their ongoing development (Peek, 2008). Schools are essential sites for safeguarding children and youth in disaster settings (Mutch, 2014; see also, UNISDR, 2014; ACFCSS, 2016; Paci-Green et al., 2020).

Though the significance of their role as educational institutions and resource distribution centers in disaster contexts is well-established (e.g., Sakurai et al., 2018; Mirzaei et al., 2019), consideration of schools' psychosocial influence may be vital to disaster risk management and resilience-building (IASC, 2006; Pacheco et al., 2021). Many works explore the socio-physical dynamics of spaces such as cities or the home (e.g., Bechtel, 2010; Clayton, 2012; Fleury-Bahi et al., 2017; Sawyer et al., 2022), yet to our knowledge, the literature lacks academic conceptualization of the socio-physical elements of schools. This conceptual analysis explores the evidence regarding how children conceptualize schools in disaster settings; it examines how schools may mitigate psychosocial risk for children by considering the function of these conceptualizations from a social psychological perspective. We conclude with a series of recommendations for utilizing schools as hubs for enhancing resilience in disaster contexts.

Before we begin our conceptual analysis, we briefly clarify definitions of key concepts used throughout this paper. Since the United Nations International Strategy for Disaster Reduction adopted the Hyogo Framework for Action (HFA) 2005–2015: '*Building the Resilience of Nations and Communities*', disaster policy, planning and research has focused on the capacity of the community to bounce back from adversity. Yet despite the rise in popularity of the resilience rhetoric, there has been a lack of interdisciplinary consensus on how the concept is defined (Mayunga, 2007; Bonanno et al., 2015). We view it as the 'adaptive capacity' that supports individuals and the community to cope with and recover from adversity (e.g., Berkes, 2007; Paton, 2007; Norris et al., 2008; Masten, 2011; Ungar, 2011). The adversity we refer to is that experienced in settings affected by disasters. While disasters vary in the scale of disruption and loss of life caused, a disaster setting is an area that has experienced widespread human, material, economic and/or environmental loss as a result of the interaction of a hazard (e.g., an earthquake, tsunami, flooding) with social vulnerability (Massazza et al., 2019). Resilience building is facilitated through a system of processes that buffer the impact of such disaster scenarios and improve circumstances in both the short-term response and long-term planning (Pacheco et al., 2021).

## Background and framework

This section explores how spaces can protect the psychosocial resilience of individuals and communities; we approach this through lenses of social representations theory (SRT), sense of place and place attachment theory. Subsequent sections apply this knowledge to understand the significance of schools (as physical and social environments) for children and youth in disaster settings. Within this paper, 'schools' refers to primary and secondary, but not tertiary, education.

### Social representations theory

Social representations are the product of group-based meaning-making practices whereby groups socially construct common knowledge on topics of social relevance (Moscovici, 1961/1976, 1984; Clémence, 2001). Abstract concepts are made concrete by their transformation into elements that are easier for people to engage with and discuss, such as integrating the concept into images or examples with relevance to everyday life (Clémence, 2001). The objectified concepts become fully integrated into contemporary meaning systems when connected to pre-existing meaning systems (Joffe, 2003). Such representations exist not only in belief and discourse but influence, and are inseparable from, social behavior (Sammut and Howarth, 2014; Wagner, 2015). It is therefore useful to draw on SRT to explore the symbolic meaning with which schools are infused in disaster settings.

People can differ in how they represent an entity. When people represent important social issues, their pre-existing cognitive-emotional frameworks are imposed upon the newer ideas; groups within the wider public draw on diverse information sources to understand a phenomenon (Abreu Lopes and Gaskell, 2015). The pre-existing frameworks are shaped by the complex social worlds within which the people exist (e.g., religious, cultural, ethnic, political, socioeconomic and ideological; Clémence, 2001; Staerklé et al., 2011; Wagner, 2012) so that contemporary societies experience a plurality of representations of the same object (Abreu Lopes and Gaskell, 2015). Such frameworks influence belief structures, life experience and knowledge acquisition (Staerklé et al., 2011); they become more salient when a threat is encountered (Joffe, 2003; Jaspal et al., 2022).

Although SRT has been applied to understanding risk (Joffe, 2003; Lemée et al., 2019) and representations of the home (Harries, 2013) in disaster settings, it has yet to be applied to understanding the content or implications of conceptualizations concerning schools in disaster settings.

### Sense of place

The literature provides a plethora of definitions and concepts for characterizing the complex processes whereby humans develop connections to places, such as place attachment (Hidalgo and Hernández, 2001; Altman and Low, 2012; Scannell and Gifford, 2016, 2017; Manzo and Devine-Wright, 2020), sense of community (McMillan, 1996; Obst et al., 2002), sense of place (Jorgensen and Stedman, 2001; Pretty et al., 2003; Silver and Grek-Martin, 2015), place identity (Twigger-Ross and Uzzell, 1996; Devine-Wright, 2009; Foroudi et al., 2020), rootedness (Relph, 1976; Tuan, 1980), belonging (Inalhan and Finch, 2004; Rogaly and Taylor, 2016; Di Masso et al., 2017), place-making (Trudeau, 2006; Friedmann, 2010; Pierce et al., 2011; Ujang, 2012) and making sense of place (Matthews, 1992; Relph, 2009; Powell, 2010; Convery et al., 2014). Each of these terms appears across

disciplines interested in place-related research (e.g., urban studies, psychology, human geography, sociology), and has been operationalized across the research literature within concrete variables (e.g., quantitatively captured in years lived in an area) as well as abstract variables (e.g., qualitatively captured in how one understands one's experience of or in a place; see Lewicka, 2010; Williams, 2014; Greer et al., 2020). While many authors use these terms interchangeably, a rich literature is dedicated to untangling each of these concepts (e.g., Hashemnezhad et al., 2013; Collins-Kreiner, 2020). Lewicka (2010), who provides an extensive review of several hundred empirical and theoretical works, argues that the literature should turn away from pursuit of defining these terms within rigid parameters and, instead, work toward extending theory and conceptualizations of person-place attachments in under-researched populations and settings. We respond to this challenge: there is little previous thought concerning the meaning ascribed to schools within communities, and none, to our knowledge, concerning this topic in disaster settings.

Schools' meaning in disaster settings can be informed by understanding how individuals and groups develop psychological ties to places. All environments are social and physical (socio-physical), allowing person-place interactions to be bidirectional on a series of interacting levels: The thoughts, feelings, and behaviors of a person influence the elements of a place, and the elements of a place influence the thoughts, feelings, and behaviors of the individual experiencing that place (Sörqvist, 2016). Places contain three components: location (i.e., absolute and relative space), locale (i.e., material features that exist in that space), and sense of place (i.e., affective interactions with elements of that space; Silver and Grek-Martin, 2015). Location and locale refer to the external elements (built and natural) of a space. Sense of place refers to the affective psychological orientation – memories and experiences - that individuals or groups have in relation to a spatial setting. These contribute to the location and locale becoming a meaningful place (Jorgensen and Stedman, 2001; Silver and Grek-Martin, 2015). Jorgensen and Stedman (2006) further describe sense of place as a general complex psychosocial structure that organizes beliefs, emotions, and behaviors. Since sense of place acknowledges that the meaning people ascribe to a place is a dynamic, multidimensional product of subjective processes, disaster studies tend to favor sense of place as a lens to explore the psychosocial ways in which communities have been affected by natural hazards (e.g., Chamlee-Wright and Storr, 2009; Smith and Cartlidge, 2011; Silver and Grek-Martin, 2015; Bonaiuto et al., 2016). Thus, sense of place research strongly informs and guides this work in conceptualizing schools' symbolic and affective meaning for communities in disaster settings.

## Place attachment

Most scholars consistently uphold that sense of place is a product of place attachment (e.g., Shamsuddin and Ujang, 2008; Kudryavtsev et al., 2012). Even though the literature lacks a clear, single definition of place attachment, it is most consistently described as the subjective bonds people develop with particular places they hold important or meaningful (Hidalgo and Hernández, 2001; Greer et al., 2020). Place attachment has commonality with attachment to a person (Fullilove, 1996), encompassing the emotional and cognitive experience linking people to places (Bonaiuto et al., 2016) and captures the meaning individuals make of their environments and how they interact with those environments (Lewicka, 2005; Greer et al., 2020, p. 307–308).

Scannell and Gifford (2010) synthesize the literature concerning the various elements that contribute to place attachment in a well-cited and evidence-based tripartite model that envisions place attachment as a product of three dynamic elements. The *person* element concerns the actor who is attached; *place* concerns the object of attachment, including concrete and abstract elements of a place to which one is attached; psychological *process* refers to (how the attachment manifests; psychological elements of attachment; see also, Lewicka, 2011; Counted, 2016; Manzo and Devine-Wright, 2020). To contextualize this framework for disaster settings, Jamali and Nejat (2016) provide a broad conceptual map of demographic, socioeconomic, spatial and psychological factors that act as 'parameters of place attachment'. However, they do not delve into the psychological factors. In a review of the literature on community disaster risk reduction, recovery, and resilience as well as place attachment and young people's experiences of place in disaster settings, Scannell et al. (2016) argue that place attachment is important for young people's experiences at each stage of the disaster (e.g., preparedness, experience, recovery and resilience). However, they find that while themes relevant to place attachment are often mentioned in empirical findings in disaster social science research, they are rarely discussed in the context of specific place attachment theory, especially in research on children and youth. A social psychological lens has been notably missing from the place attachment and disaster resilience discourses (Lewicka, 2011; Pacheco et al., 2021). This paper endeavors to address this gap as a social psychological lens can help us to conceptualize how places (i.e., schools) can act as icons of recovery for youth (Cox et al., 2017), such as by fostering emotional regulation and positive affect.

# Framework and method

This paper seeks to explore how pupils represent schools in disaster settings and the implications of these representations for resilience building. Existing evidence is assimilated and combined to support arguments using a theory synthesis (Jaakkola, 2020). This is a conceptual integration across multiple literature streams. It offers an enhanced view of a phenomenon by linking previously unconnected pieces in a novel way.

This paper seeks to synthesize the sense of place, place meaning and place attachment literatures insofar as they

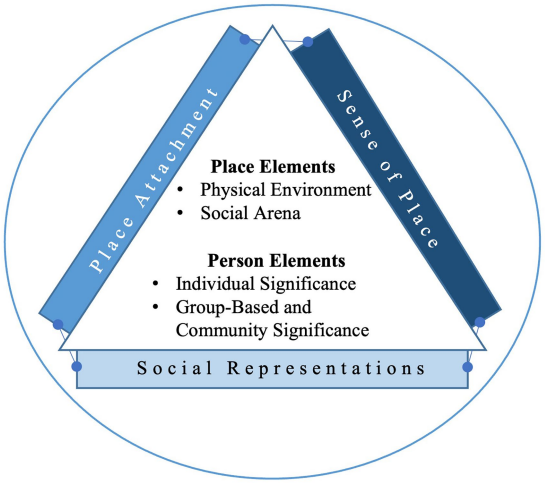


FIGURE 1
Conceptual framework for understanding the functional resilience building elements of schools. We consider how schools may mitigate psychosocial risk for young people in disaster settings across four elements; these elements are conceptualised based on a unified framework (lens) between place attachment, sense of place and social representations theories.

characterize the person-place bond (see Figure 1). This bond contains psychosocial, affective and bidirectional (see also, Lewicka, 2011) facets. Doing so provides an academic foundation for understanding how schools are ascribed meaning by people in disaster contexts (sense of place) and the socio-physical elements of schools that may influence these representations (place meaning and place attachment). We also consider the nature of individual and group-based (i.e., community) ties to schools in disaster settings and explore identity dynamics that contribute to these environments being represented as personally and symbolically significant.

## Schools as meaningful places in disaster settings

Young people's representations of schools are characterized by cognitive-affective meaning. Beyond their capacity as educational institutions, schools provide their communities with necessary, supportive resources during disaster response and recovery phases. They are often repurposed as shelters or evacuation centers (Mutch, 2015). Beyond these practical functions, schools are also important social environments to which people develop physical, moral, social, emotional, spiritual, aesthetic, and academic attachment (Noddings, 2005; Rich and Schachter, 2012). Such attachments are especially salient for young people and may endure over the life course. For example, young people often represent schools as protective spaces (Sinkkonen, 2012). Research suggests young adults continue to retain these representations; Scannell and Gifford (2017) found that spontaneously visualizing familiar places, including schools, enhanced undergraduates' sense of belonging, self-esteem, and meaningfulness. These findings suggest that schools have enduring socio-physical qualities and demonstrate that the person-place bond between pupils and schools may provide psychological benefits.

We structure our conceptualization of the place meaning of schools for children and youth in disaster settings by considering the meaning of schools as (1) physical built environments, (2) social arenas, (3) places with personal, and (4) group-based significance. We draw on the Scannell and Gifford (2010) model of place attachment as it provides a systematic pathway through the core elements that interact in fostering a place bond.

## Schools as physical places and built-environments

The concept of place, most commonly defined as space endowed with meaning (Relph, 1976; Tuan, 1977; Low and Altman, 1992), is the object of attachment within place-attachment theory (Scannell and Gifford, 2010). It is well-acknowledged that the physical attribute of 'place' has been under researched compared to the over-emphasis on the social dimension of place attachment (Stedman, 2003; Droseltis and Vignoles, 2010; Lewicka, 2011; Sebastien, 2020). This absence is particularly notable concerning young people in the disaster literature (Cox et al., 2017). In child samples much of the recent research concerning the meaning of physical places considers the importance of green spaces (e.g., see Little and Derr, 2020 for a review) and the promotion of pro-environmental behaviour through place attachment (Cole et al., 2021). In this body of research, the scale of meaningful built environments in a child's life vary, from the small-scale (e.g., a bedroom) to the large scale (e.g., a city; Little and Derr, 2020). For children and youth, the physical aspects of such environments may be more salient than for adults. Morgan (2010) explains that adults' attachment is driven by their feelings of a place and the meaning attributed to those feelings. In contrast, children understand places based on what one can do in the place (e.g., play, self-directed exploration) with little regard for the purpose of the place or the social meanings. As the environment is a passive element in relation to the activity, the bonds fostered in children are initially unconscious but become conscious as children are involved in repeated person-environment interactions and begin to develop feelings about those interactions (Jack, 2010). Significant physical places can benefit young people by satisfying physical and emotional needs, as they have been found to provide a sense of comfort that supports cognitive restoration and emotional regulation (Korpela et al., 2002). Important physical places can also provide a symbolic function. In disaster settings there is emerging evidence that a range of physical places, including the home and school, become symbols of recovery for young people. For example, arts workshops involving youth between the ages of 13–22 across four disaster-affected communities in the United States and Canada

highlighted key people, places, and activities that supported their recovery (Cox et al., 2017); these insights were based on local knowledge and lived experience, demonstrating that it is important to collect and document youth perspectives when contextualizing theories of disaster recovery. The finding that physical places symbolize recovery after disaster has been well-evidenced in adult samples (Cox and Perry, 2011; Silver and Grek-Martin, 2015).

The development of person-place bonds varies according to developmental need (Morgan, 2010), and the role of schools in children's lives continues to evolve, as do the nature of the interactions. For example, the journeys to and from school are important person-place interactions for children. They provide valuable opportunities for unstructured interaction with their social and physical worlds, which contribute to the development of their personal and community identities (Jack, 2010; see also O'Brien et al., 2000; Ross, 2007; Scannell and Gifford, 2017). These journeys allow children to actively engage with local space, contributing to secure attachments to the broader school locale and belonging to place (Jack, 2010). Future research could explore whether different modes of transport have unique psychological benefits, for example whether walking may foster attachment to the locale whereas a car journey may foster parent–child attachments. After Hurricane Katrina Forthergill and Peek (2015) conducted interviews and observations of children that revealed playgrounds and ball fields to be important places for recovery. Overall existing research supports the notion that schools exist as important physical places in children's lives as they provide a context that scaffolds developmental growth and contributes to sustained psychological wellbeing.

# Evidence

## Schools as built environments

### Macro-level assessment of how the overall physical environment directly impacts pupils' lives

The built environment of schools has been empirically documented to impact pupils directly. For example, environmental psychologists demonstrate that the architectural environment of American primary schools predicts both attendance and academic achievement after controlling for other predictors such as socioeconomic status, ethnicity, school size, and teacher quality (Durán-Narucki, 2008). There is also a positive association between academic achievement and middle-school building conditions, mediated by social climate and student attendance (Maxwell, 2016). The destruction of school settings following natural hazard events prevents children from returning and receiving education (e.g., Mudavanhu, 2014; Adeagbo et al., 2016; Kousky, 2016). Thus, the maintenance of adequate school facilities is essential to protecting children's right to education and their psychological wellbeing. These studies offer a macro-level assessment of how the overall physical environment directly impacts pupils' lives, demonstrating that poorer facilities correlate with poor attendance and, therefore, poorer academic outcomes.

### Micro-elements of spaces

Micro-elements of spaces that carry little meaning for adults have been shown to have great significance for young people (Koller and Farley, 2019). For example, Fleet and Britt (2011) found that children placed significance in a brick wall, which researchers initially saw as meaningless. Drawing on Stedman's (2003) 'meaning-mediated model', it is unlikely children were attached to the wall *per se*, but instead, the meaning represented by the wall, such as warmth and laughter (Koller and Farley, 2019). This is consistent with findings reported by Fleet and Britt (2011), that children often climbed and sat on the wall, creating new narratives of the wall's significance through play. These person-place interactions also effectively subvert the adult narratives of safety and surveillance, which creates a sense of adventure and freedom that Scannell and Gifford (2016) theorize fosters positive attachments to place elements in children. Other studies have also documented differing affective responses to micro place elements. Koller and McLaren (2014) found that children shared spontaneous and charged emotional responses to hospitals' physical design and decor that was not shared with adults. This demonstrates the importance of eliciting children's insight into the meaning with which certain physical aspects of the school environment are endowed, as adults may be unaware of the meanings bestowed on seemingly mundane features of the school environment.

### Place loss in disaster settings

The literature concerning place loss in disaster settings provides further insight into the relationship between bonds to physical places and psychological wellbeing. According to the disaster literature, the loss of physical place, most notably the home, is devastating for adults. Feelings of grief and emotional distress often accompany place loss, as cognitive-affective attachments are ruptured (Cox and Perry, 2011). This occurs beyond the initial disaster impact, as ongoing demolition leads to feelings of disorientation throughout the reconstruction period (Silver and Grek-Martin, 2015). Such disruption to one's significant places can lead to "solastalgia," which refers to the distress produced by environmental change (Albrecht et al., 2007). When "solastalgia" occurs, the environment no longer offers solace, sense of place and place identity, causing feelings of powerlessness that negatively impacts wellbeing (Warsini et al., 2014; Albrecht, 2019; Galway et al., 2019).

The impact of place loss on children is likely to become more salient for children post-disaster since they become aware of the attachment they had to the destroyed place and experience exacerbated feelings of distress due to the suddenness and unexpected nature of the impact (Relph, 1976; Cheng and Chou, 2015). To understand the symbolic significance of the loss of physical place, we turn to research that examines material loss

through the lens of Moscovici's (2001) social representations theory. The home is often depicted as a place of safety, security and relaxation. Harries (2013) found that residents at risk of flooding in the UK are motivated to protect elements of the home that facilitate feelings of safety; the elements which function in this way are largely determined by social representations. However, traumatic or repeated damage to a home can threaten residents' ontological security (Hawkins and Maurer, 2011; Harries, 2013), which occurs when a sense of trust in the stability of the home environment is undermined. Just as the home is associated with notions of continuity and safety for adults (see Mallett, 2004 for a review), many young people often see the school as a place of inclusion and safety (Butler et al., 2017). As children spend a large amount of time at school, a similar process may occur: the group-based sense of the school as a safe space (pre-disaster) may be challenged by a school becoming a place of danger, especially where there has been a threat to life (e.g., building collapse during an earthquake). This will have an emotional impact on the children. If both a sense of safety and of danger are held simultaneously, this may lead to what Moscovici (1984) terms 'cognitive polyphasia': representations may be plural and even contradictory, activated depending on the social context. For example, post-disaster children may simultaneously represent the school as a place of safety when among supportive peers and adults, and danger when witnessing infrastructural damage. Although this provides insight into the unique subjectivity of person-place bonds for children (versus adults) and peripherally informs our understanding of meanings made of schools, this area remains under-researched.

The process of rebuilding schools should be emphasized in community response and recovery plans. Scholars argue that involving children and youth in the design efforts is likely to benefit their wellbeing and cultivate positive place-attachment bonds to the place they have agency in creating. For example, Koller and Farley (2019) advocate for the right of children to be involved in the design of the spaces they inhabit. Research from disaster-affected areas has also shown that young people eager to be active in community recovery post-disaster (Peek, 2008; Taylor and Peace, 2015). Further, Pivik (2010) argues that children's insights into place differ from adults' and documents instances where children have identified barriers to the inclusion of disabled children that relevant adult stakeholders were unable to identify. The unique student perspective should be harnessed when physically rebuilding the school post-disaster to ensure the built environment meets young people's needs, to truly 'build back fairer' (Sendai Framework for Disaster Risk Reduction 2015–2030) from a child-centered perspective.

## Schools as social arenas

This paper has thus far explored place meanings in terms of the physical, built environment. However, place is often considered a dual concept that incorporates a social element within the physical environment (Riger and Lavrakas, 1981; Scannell and Gifford, 2010; Koller and Farley, 2019). The relationship between both dimensions is symbiotic: bonds to physical places facilitate meaningful networks of relationships, just as meaningful relationships shape the meanings attributed to a physical place (Tuan, 1977; Hay, 1992). Schools are key sites for developing and maintaining social relationships, especially for children (Ellis, 2005). Yet, little research has explored or conceptualized the role of schools as social arenas and how they may come to exist as meaningful places for communities in disaster settings. This section outlines the social aspects of schools that serve significant functions in supporting children and youth in resilience building and psychosocial recovery.

### Social support networks

For children in disaster settings, social support networks are vital resources. They introduce a plethora of protective psychosocial factors, such as sense of belonging and connection, into their lived experiences; these buttress psychological wellbeing. The notion that social support can 'buffer' the negative effects of stress on mental health for children and adults is well supported by contemporary research (Olstad et al., 2001; Cohen, 2004; Sharp et al., 2018; McGoron et al., 2020). As young people are happiest in places that facilitate access to peers and supportive adults, schools are especially significant social arenas for children in disaster settings because these environments provide access to multiple social actors (Chawla, 1992, cited by Ellis, 2005).

Schools provide opportunities for unique social connections that would not normally exist outside the school environment but are vital for safeguarding children's wellbeing. For example, positive teacher-student relationships are protective against a series of risk factors for children, including depression, neglect, and bereavement (Wang et al., 2013; Sharp et al., 2018). These adult-child relationships are unique to the school settings (i.e., non-familial) and are often central in safeguarding children (Bhadra, 2016). After Hurricane Katrina, for young people required to change school, the positive support received from school staff was instrumental in supporting their wellbeing (Barrett et al., 2008). Teachers have been shown to go beyond their traditional roles to aid children in processing their disaster experiences, which involves regulating their own emotional responses to model effective coping (Mooney et al., 2021).

Schools also provide the greatest opportunity for friendships amongst children; these social relationships have been found to promote positive coping with psychological distress following a disaster. For example, a seminal study found children's friendships to be the most salient providers of emotional support and coping assistance following a hurricane – more so than parents and teachers (Prinstein et al., 1996). Emerging insights from disaster settings also show friendships as drivers of returning to school. Empatika (2018) reports that young people in Palu, Indonesia, ranked highly their desire to return to school and reconnect with friends following the 2018 earthquake and tsunami. Play and sport are critical school-based activities that scaffold such peer-to-peer

social connection; they foster psychological wellbeing and post-traumatic growth for children in disaster settings (Henley, 2005; Ray and Bratton, 2010; Goodyear-Brown, 2019). These activities are also drivers of childhood attachment to schools as play and sport are mechanisms through which children engage in valued person-place interactions and build a salient, positive place-bond with their schools (Scannell and Gifford, 2016).

After a disaster, the restoration and rebuilding of schools can symbolize the community's resilience. School recovery allows children to return to normalcy and replace their emotional crises with the joy of being surrounded by other children and having a space to learn and play simultaneously (Fernandez et al., 2015; e.g., Telford and Cosgrave, 2006). Young people are more likely to engage in their usual activities (relative to local context) when they believe their teachers and friends support them, even when faced with considerable difficulties (Wickrama and Kaspar, 2007). It is especially important for children to re-engage in play, as it can alleviate traumatic stress (Fernandez et al., 2015). School recovery also benefits communities since it allows parents and guardians to focus on returning to their regular work, to sustain their families, while their children are at school. Returning to work activities also aids in the recovery of communities by contributing to economic recovery. Communities with high social capital and a history of community activities can take an active role in the process of economic recovery and contribute to its success and speed (Nakagawa and Shaw, 2004), which is essential in safeguarding children's wellbeing.

### Sense of connectedness between community members

Beyond what they symbolize for children, schools are important social arenas that facilitate and embed a vital sense of connectedness between community members. When a community harbors a sense of social connectedness (e.g., between family, friends, and neighbors) before a disaster, it benefits from a greater sense of community and camaraderie post-event, which then promotes its adaptive potential and resilient capacity (Thornley et al., 2014; Mutch, 2015). This effect is consistent with the 'social cure' in the context of public health, where group-based processes of social support and social integration are found to contribute to positive health outcomes (Haslam et al., 2018). However, communities require appropriate local infrastructure and a community hub for community connectedness to benefit preparedness, adaptation, and recovery in disaster settings (Thornley et al., 2014). Schools are well-documented as ideal community hubs for local disaster risk management planning: from a disaster risk perspective, schools are often built better and built safer; from a psychosocial perspective, they are familiar, stable, and often locally accessible environments in times of emergency (Leadbeater, 2013; Mutch, 2015; Oktari et al., 2018; Amini Hosseini and Izadkhah, 2020).

Overall, social networks play an important role in promoting wellbeing and resilience for children and communities. Cohesion in the community reduces the mental health burden on a community post-disaster. As social connections are documented protective factors, which buffer against (dis)stress, the importance of promoting and protecting social connection within communities in disaster settings is emphasized. Schools are meaningful places that act as repositories of social relationships with protective functions vital to safeguarding the wellbeing of children and their communities post-disaster.

## Schools as places of personal significance

The paper has thus far explored the meaningfulness of schools as built-environments and as social arenas, supporting the wellbeing and resilience of children in disaster settings. It moves on to the personal elements contributing to the person-place bond for these children. Specifically, we consider the nature of individual factors, such as lived experience, and group-based ties, such as religion and history, in disaster settings. We demonstrate how such psychosocial ties are often the cause and consequence of complex identity dynamics, which influence how schools are represented.

### Place identity

The process of person-place bonding is marked by direct and indirect interactions between the person and the place (Scannell and Gifford, 2010). These interactions include what one does in the place (e.g., activities, social interactions) and how one feels about it (e.g., safe, comfortable, welcome). The paper has previously discussed the significance of what one does in the place, and now considers the significance of how one feels about a place.

When the meaningfulness of a place deepens over time, place attachments can evolve further into place identity: a process through which individuals come to incorporate cognitions about the physical environment into their self-definitions (Clayton, 2003; Gifford, 2014). Prolonged and repeated exposure imbue environments with meaning at the individual level, especially where these exposures provide opportunities for interaction with the environment and people within it (Lewicka, 2011; Anton and Lawrence, 2014). Repeated experiences of places in childhood contribute greatly to lifelong person-place bonds (Jack, 2010), which function in a similar way psychologically to an interpersonal attachment (e.g., Fried, 2000; Kelly and Hosking, 2008; Morgan, 2010; Donovan et al., 2012; Scannell and Gifford, 2014, 2017).

Child-school bonds can comprise strong affective, social, and cognitive elements that often endure throughout the life-course. The mechanisms that shape such feelings about a place and foster such enduring person-place bonds also shape sense of self and community, and influence psychological wellbeing (Ellis, 2005). There is a well-established link between identity consistency and psychological wellbeing in the academic literature (Rogers, 1951; Phinney et al., 2001; Greenaway et al., 2016, as cited in Suh, 2002); this includes place identity as it is a substructure of social identity,

similar to gender or social class (Shamsuddin and Ujang, 2008; Qazimi, 2014). Though the complex relationship between identity and wellbeing is not clearly understood at present, the literature reflects that the gaining of identity and consistency can protect and enhance wellbeing (e.g., Ysseldyk et al., 2012; Praharso et al., 2017) while disruptions to identity can be severely problematic and are linked with deleterious outcomes.

When place identities are threatened, this can also lead to place-protective action, including local opposition to proposed developments to the built environment, such as wind turbines (e.g., Stedman, 2002; Devine-Wright, 2009). Following disasters, schools may be relocated, merged or closed if they are in a dangerous zone or no longer have enough pupils to remain viable. After the Canterbury earthquake, this was found to exacerbate the social and emotional stress of a trauma-affected community (Mutch, 2018). Although unexplored in the existing literature concerning schools, place identity may impact the community response to such closures, in the form of protests and legal action. Thus, identification with places that are stable, enduring environments can act as a protective mechanism, but can also become problematic and undermine resilience when left unmitigated. For example, Bihari et al. (2012) found that place attachment was associated with greater knowledge of wildfires and effective preparedness across six communities in the United States. However, Donovan et al. (2012) found place attachment to territory and landmarks interacted with culture to minimize evacuation behaviors for an Indonesian community under threat of volcanic activity. Beliefs in protective ceremonies and spiritual forces minimized evacuation behaviours.

## Meaning-making and appraising traumatic events

Schools may foster positive meaning-making outcomes because they exist as trusted places to which pupils and communities harbor positive cognitive and affective ties. As schools provide many resources to support their communities, accessing these places post-disaster can support adaptive coping practices. For example, being in a state of disrupted identity can be traumatic, especially for children who may not have the cognitive-affective tools to independently cope with or appraise events. Such adverse responses to traumatic experiences are due to the loss of 'meaningful' resources, including psychological and cultural resources (Hobfoll, 1989). Meaning-making is a key process through which people rectify disturbances in their sense of identity and maintain homeostasis (see Linley and Joseph, 2005; Park, 2010; King and Hicks, 2021). Finding meaning in a traumatic experience is an example of this process; which can be a stressful-inducing process, but also has the potential to lead to outcomes that enhance psychological wellbeing (King and Hicks, 2021). The meaning-making process is central to supporting recovery after disaster (Park and Blake, 2020). Schools are a vital resource drawn upon to influence how stressful a disaster is for its pupils. For example, after Hurricane Katrina, pupils who felt more connected to the school they had been relocated to reported fewer negative symptoms and more protective factors (Barrett et al., 2008). Schools may potentially act as places that can activate positive representations post-disaster as they are familiar spaces.

## Social representations and attachments to schools

To understand the psychosocial significance of schools in disaster settings, it is necessary to consider how they are valued by the communities within which they exist. The significance that individuals ascribe to a place is shaped by their lived experience in the context of the group-based meaning system of their community (Bruner, 1990; Van Patten and Williams, 2008); when a person's social world has already identified a particular place as meaningful, the place symbolizes the group-based cognitions that formed the social representation(s) of that place, according to how or why it is valued by the group (Low and Altman, 1992; Joffe, 2003; Scannell and Gifford, 2010). In Social Representational terms, this section explores how the socio-cultural group representations of the school become internalized in the individual, that is, "how the 'we' becomes contained in the responses of the 'I'" (Joffe, 2003, p.60).

Representations of schools influence how these places are encountered and utilized by their communities. Like religious institutions or museums, schools are associated with their specific function and are valued according to how these functions serve their communities. Social representations that circulate in a given culture refer to shared understandings of phenomena among a specific group (Joffe, 2003). While there is plurality of representations of school depending on socio-cultural, historical context, and group-specific ideologies, schools tend to be regarded as trustworthy places dedicated to the betterment of the character and knowledge of their pupils and cultivating their growth and resilience (Bryan, 2005; Luetz, 2019). In addition, in disaster settings, schools are also regarded as disaster risk reduction centers that support their communities at all stages of disaster: preparedness, response, and recovery (e.g., Sakurai et al., 2018). Schools facilitate the resilient recovery of post-disaster communities through educational disaster preparedness programs, staff safeguarding of children's wellbeing peri- and post-event, and converting the building into a resource distribution center (Mutch, 2015). By bringing people together in a shared and familiar space, schools also promote a 'culture of caring' in communities post-disaster (Mutch, 2015). Each of these functions reinforces the community's representation of their local school as a trustworthy place and further informs their representations of the significance of schools in disaster settings. As schools continue to support their communities in this way, shared beliefs that they are valuable becomes increasingly reinforced.

The significance of schools as symbols can also be understood by considering the psychosocial functions of memorials. Bonder

(2009) explains that memorials help individuals and communities reappraise past traumatic events, while also existing to remind them about conduct and future events. It is well established that a sense of shared identity emerges amongst survivors in post-disaster settings, as the communal experience of the disaster prompts a sense of 'we-ness' (Rodríguez et al., 2006; Drury et al., 2016). While post-disaster gains in social capital are often short-term (Kaniasty and Norris, 1993), memorials can function to maintain these ties and evolve into a source of enduring community resilience (Ntontis et al., 2020). Memorials are also inextricably linked to space, thus if schools are used as a site of memorial the physical space of the school has the potential to become an 'anchor of shared identity' (Ntontis et al., 2020, p. 7) rooted in deeply person-centric elements of individual and group attachment. Therefore, schools can benefit from harnessing this sense of 'we-ness' experienced by shared fate after an earthquake in order to build resilient communities in highly seismic/disaster-prone regions.

## Conclusion

This paper has presented an evidence-based conceptualization of how and why schools exist as meaningful environments for children and their communities in disaster settings. It has considered the physical and social environments of schools and their significance at the individual and group levels (e.g., community). We have explicated a series of specific functions within each of these domains that make schools distinctly meaningful to their communities and highlighted the capacity of schools to foster community resilience and safeguard the wellbeing of children. We have also considered the nature of individual and shared ties to schools in disaster settings and demonstrated how such psychosocial ties are often the cause and consequence of complex identity dynamics that contribute to these environments being represented as symbolically significant. The mechanisms uncovered concerning how schools can provide these functions have important implications for the role of schools in mitigating the adverse impacts of disasters.

## Recommendations for future research

Based on the evidence concerning place bonds, we have attempted to synthesize existing frameworks to contribute a holistic conceptualization of how schools can bolster resilience in disaster settings. We intend for this knowledge to allow academics and practitioners in disaster preparedness and response to better understand and harness the school environments' latent capacity to improve and protect community members before, during, and after disasters. For example, by exploring schools through a broad social psychological lens of place-bonds and attachment, we highlight that rebuilding the school's physical infrastructure should be a priority in community disaster response and recovery efforts. We use a social representations theory approach to highlight that schools are community resources that can be used to foster community integration and cohesion, provide children a sense of stability and continuity, and provide pragmatic support to community members. Each of these functions safeguards wellbeing and fosters resilience across a series of psychosocial domains. Thus, while the loss of the physical place is traumatic, rebuilding a school after a disaster may symbolize community and communal continuity. Contemporary scholarly works have only begun to capture this notion; Dimension.ai, an opensource database that offers analytics of linked data, including grants, publications, datasets, patents, and policy documents, reports that interest in schools in disaster settings has been steadily increasing. This paper provides a foundation for dialogue to consider the socio-physical function of schools in communities and the lives of the individuals who spend time in these spaces (e.g., pupils, staff, parents/families). Future research should also aim to establish insight into how place attachment functions in seismic areas pre-disaster.

## Limitations

This paper expands on the contributions and syntheses provided by well-cited, prominent works concerning the person-place bond. However, it does not adhere to a single model or rigid conceptual framework. We acknowledge that this approach may have left some aspects of the place bond to schools unexplored and recommend that future research expand on our preliminary conceptual insights by empirically exploring the role and meaning of schools in disaster settings. We consider existing knowledge in social psychology, such as the person-place-process (Scannell and Gifford, 2010) and the self-other-environment (Gustafson, 2001) models of place attachment, but future research would benefit from approaching this topic through other lenses in order to deepen understanding. While this paper has regarded schools and the school environment as a place with positive valence, we also acknowledge that schools may not provide a positive experience for all people or in all places. For example, some schools have a more positive climate than others, which can impact mental health (Patalay et al., 2020). Just as social representations of the 'home' as a sanctuary do not reflect the lived experience of everyone (Mallett, 2004), we acknowledge that this may also be the case for representations of the school. Furthermore, some young people may have negative experiences of bullying, lack of belonging, and loneliness. This concern is especially important to note as children with special educational needs may be more vulnerable to feeling excluded (e.g., Cullinane, 2021). Future research should explicitly explore the critical role played by schools for children with special physical and educational needs, as schools may have different value and significance than captured in this

paper. Finally, it must be recognized that the type of attachments pupils have may vary according to their age; future research should empirically explore the psychosocial role of schools for children and adolescents separately.

## Author contributions

E-MP, EP, and HJ: conceptualisation. E-MP and EP: writing – original draft preparation. E-MP, EP, RO, and HJ: writing – review and editing. HJ: supervision and funding acquisition. All authors have read and agreed to a published version of the manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# How do people feel while walking in the city? Using walking-triggered e-diaries to investigate the association of social interaction and environmental greenness during everyday life walking

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**Background:** Light to moderate physical activity, which includes walking, is associated with positive effects on physical and mental health. However, concerning mental health, social and physical environmental factors are likely to play an important role in this association. This study investigates person-place interactions between environmental characteristics (greenness, social interaction) and momentary affective states during walking episodes. A within-subject design is implemented, in which affective states and environmental characteristics are assessed while participants are walking outside.

**Methods:** On smartphones, coupled with a motion sensor (move3), e-diaries were triggered as soon as people walked 100m outside. E-diaries assessed momentary affective states (valence, calmness, energetic arousal), and social interaction (walking alone; seeing other people while walking; interacting with other people; walking with a known person) between 6am and 10pm over nine days. The percentage of greenness was determined afterward from recorded GPS and GIS data. Demographics were collected in advance *via* an online questionnaire. Multilevel models were calculated with R for 46 individuals (age=41.2, ± 13.2; 52% female).

**Results:** Affective state dimension energetic arousal showed a significant association with social interaction and greenness, i.e., participants rated energetic arousal lower when walking alone, and if there was less greenness vs. when interacting shortly with someone while walking ($\beta$=0.13, $p$=0.02), and being in situations with more greenness ($\beta$=0.08, $p$=0.02). Furthermore, associations with social interaction and greenness were found for dimension calmness: walking together with someone was associated with higher calmness ($\beta$=0.16, $p$=0.02), and the higher the proportion of surrounding

greenness during a walk, the higher calmness was rated, i.e., participants were calmer ($\beta$=0.09, $p$=0.01). Significant associations with valence were not present.

**Conclusion:** The findings indicate that the affective states varied significantly due to different social and physical environmental factors. In the future, the importance of environmental factors should be further investigated, e.g., by assessing environmental factors right in situations contrary to a subsequent imputation. Within-subject designs, and in particular triggered assessments with the addition of GPS, can aid in developing interventions for health-promoting urban environments.

KEYWORDS

**ambulatory assessment, mental health, active mobility, social interaction, greenness, momentary affective states, ecological momentary assessment, environmental factors**

## Introduction

Walking, as a subcategory of physical activity (PA), representing low- to moderate PA, is associated with positive effects on individuals' health and wellbeing (Ekkekakis et al., 2008a; Ettema and Smajic, 2015; Hanson and Jones, 2015; Wiese et al., 2018). Walking has been shown to enable individuals to achieve the WHO recommendations of a minimum of 150 min of moderate-intensity PA per week for health-enhancing effects, making it a valuable strategy for health promotion (Lee and Buchner, 2008; Wegener et al., 2017). While research regarding positive associations between walking and physical health is more consistent, this issue is more complex for mental health components like wellbeing. A closer look at study results regarding associations of PA and affective states shows that findings are not that clear and that moderating factors like the intensity of PA can play an important role: For example, it has been shown that PA levels exceeding a certain threshold can even have negative implications for individuals' emotions and moods, and lead to the displeasure of PA (Ekkekakis et al., 2008b; Biddle, 2016; Brand and Ekkekakis, 2018). Furthermore, study results often stem from laboratory settings, neglect external social- and physical environmental factors (Liao et al., 2015), and/or do not consider within-subject changes in affect over time (variability of an individual's affect over a period of time). However, that would provide more valid information about the association between walking, wellbeing, and possible moderators (Kanning et al., 2013). Therefore the goal of this study is to gain a better understanding of how affective states vary during everyday life walking episodes due to social and physical environment factors.

In line with social-ecological models, both social- and physical environments have to be taken into account to understand the association between PA and affective states, because individuals interact with- and are influenced by the surrounding environment (Guite et al., 2006; Helbich, 2018). A meta-analysis about exposure to nature showed positive effects on momentary affect: even brief contact and exposure to greenspace are associated with increased momentary wellbeing, as well as less negative and more positive affect (McMahan and Estes, 2015). In addition, it has been shown that urban greenspace that can be used (e.g., accessible parks, etc.) can have a protective effect on anxiety and mood disorder and that urban greenspace that can be observed (e.g., looking at it from home or work) can have a restorative effect (Nutsford et al., 2013). In the context of the various beneficial associations of environmental green with wellbeing and mental health, blue spaces must be mentioned as well. For example, they too have similar beneficial associations with wellbeing and mental health, and moreover have been associated with beneficial effects regarding recreation and stress-reduction that go beyond that of environmental green (Kistemann and Völker, 2014; Claßen and Bunz, 2018). Furthermore, environmental green and blue hasve been shown to be used for recreation, and to facilitate PA (e.g., walking) and social interaction (Sugiyama et al., 2008; Lachowycz and Jones, 2013; Grellier et al., 2017). An overview of evidence regarding associations of wellbeing and the physical environment shows that (urban) greenspace and also blue spaces can offer a place for and encourage recreational walking, PA, social cohesion, and facilitate social interaction among individuals, as they can bring people together (Newton, 2007; Grellier et al., 2017). Supporting these findings, Lachowycz and Jones (2013) developed a framework that highlights access to greenspace and its key moderator and mediator relationships regarding the interplay between individuals, the surrounding social- and physical environment, and wellbeing. More recent research also supports these associations that "(...) the presence of urban green spaces can encourage positive social interactions that cultivate social cohesion in ways that enhance health and well-being" (Jennings and Bamkole, 2019, p. 1). These research findings show the importance of the social context and that being socially well-integrated and having many social interactions can increase

individuals' wellbeing. Further underlining the previous findings, it was shown for both between- and within-subject associations that even brief and minor social interactions, e.g., greeting someone during a commute, promotes positive affect (Sandstrom and Dunn, 2014; Gunaydin et al., 2021). Furthermore, perceived social support can buffer against stress and negative affect (Smyth et al., 2014). In addition, social interactions, especially at social events during which individuals are physically active, showed a robust relation with high positive affect (Clark and Watson, 1988). Also, both weak and strong social ties and the social context in general (e.g., social cohesion and social interaction) are associated with individuals' well-being, with improved social interactions inducing better wellbeing (Helliwell and Putnam, 2004; Helliwell, 2012; Schwanen and Wang, 2014). In conclusion, the results show that factors from the social- and physical environment play an important role in the relationship and context of everyday life walking routes and wellbeing and affect. To be more precise, the assumption is that at least part of the association depends on the context of walking, i.e., social- and physical environmental factors. In other words, it does matter where and with whom you walk, and this "where" and "with whom" influence the walking-wellbeing association.

In this regard, affective states are often used to describe how individuals feel in different social- and physical environmental contexts, as they have been shown to be an indicator of individuals' wellbeing (Tost et al., 2019; Bourke et al., 2021; Monninger et al., 2022). In addition, affective states represent wellbeing in different situations, as they are more sensitive to the respective influences and external factors in the specific situation (Brose et al., 2013). Underlining this, walking in both urban- and natural environments has been shown to be associated with higher positive affect and energy (Kinnafick and Thøgersen-Ntoumani, 2014), and social interactions are associated with higher positive affect, more happiness, and less tiredness in daily life (Bernstein et al., 2018; Monninger et al., 2022).

However, dynamic assessments that integrate individuals and the surrounding environment are needed to gain a better understanding of these contexts (Helbich, 2018; Reichert et al., 2020). In this regard, real-time data assessment methods, such as ambulatory assessments (AA), have been proven to provide more accurate data of dynamic processes and environmental context-specific associations as well as affective states, compared to retrospective assessments methods that can produce biased data (Fahrenberg et al., 2007; Wilhelm and Schoebi, 2007; Ebner-Priemer and Trull, 2009; Dunton, 2017). Furthermore, to investigate health and behavior outcomes of complex momentary exposures in the (social- and physical-) environmental context, the addition of global position system (GPS) tracking has been shown to be a valuable add-on (Chaix, 2018; Reichert et al., 2021). In the context of this work, this means that by combining AA and GPS, it is possible to research momentary affect right in situations, in which individuals are walking outside, while also accounting for the specific environmental exposure in these situations. That the collection of data in an aforementioned way is feasible, has been shown by the authors of this paper (Kanning et al., 2022 (preprint)), and in addition, a better understanding of such time-varying relationships can provide further information about how to promote health-enhancing neighborhoods.

To our knowledge, no study has explicitly examined how social interaction and surrounding environmental greenness are associated with momentary affective states in walking situations in everyday life. One study did implement an illustrative smartphone design and examined physical (monotone–varied, dull–exciting), emotional (passive-active, sad–glad), and social (in company, social purpose of the trip) outcomes of walking, but only for a limited sample size of university students, focusing on safety and excitement issues, and without a triggered design (students were told to fill out a questionnaire either after walking for 5 min or retrospectively) (Ettema and Smajic, 2015). Contrary to the previously described data collection methods, incorporation of AA with GPS provides researchers with multiple additional benefits: It allows them to identify walking routes and implement corresponding event-based triggers, and to assess corresponding environmental features (e.g., greenness *via* subsequent imputation of Geographic Information System (GIS) data) in these situations, which enables comparison of different objective environmental features regarding their impact on affective states right in the corresponding situations. Extended knowledge about such event-specific associations between the environmental context and individuals' wellbeing in everyday life is needed to aid in decision processes regarding the design of healthy places, where individuals reside. Therefore, this study implemented walking-triggered e-diaries to examine how social interaction and surrounding greenness are associated with individuals' momentary affective states during walking episodes in everyday life. The following hypotheses, based on two predefined main effects, i.e., greenness, social interaction, and their association with affective states were formulated: in everyday life situations, in which individuals are walking outside, greenness and social interaction are positively associated with momentary affective states. In addition, we hypothesized an interaction effect between social interaction and greenness.

# Materials and methods

## Recruitment of the study participants

Subjects for this study were recruited in a two-step process. In a first step, 219 persons from several preselected urban residential areas answered a cross-sectional online questionnaire. In the second step, upon finishing the online questionnaire, participants were able to voluntarily participate in the AA by choosing one of the multiple available timeframes. Inclusion/exclusion criteria were as follows: age $\geq$ 18, no underlying physical- or mental health conditions (i.e., no restraints preventing them from being physically active, depression, etc.), an understanding of the German language,

TABLE 1 General characteristics of the study participants and data included in the analysis.

***Descriptive statistics***

| **Participants** | ***N* = 46** |
|---|---|
| Sex | 52% female |
| Age | *M* = 41 (± 13) years |
| Height | *M* = 175.2 (± 7.3) cm |
| Weight | *M* = 71.71 (± 13.9) kg |
| Education Level (higher school certificate) | 81% |
| *Prompts* | |
| Average prompts/assessment period | 8.5 |
| Average steps prior to prompt | *M* = 193 (± 95) |
| Compliance | 65.5% |
| *Variables* | |
| Valence (1–6) | *M* = 5.2 (± 0.9) |
| Calmness (1–6) | *M* = 4.8 (± 1.0) |
| Energetic Arousal (1–6) | *M* = 4.6 (± 1.1) |
| Social interaction (1–4) | *Md* = 3 |
| Greenness (in viewshed) | 33.7% (± 32.2) |

M, mean; Md, median; Parameters valence, calmness, energetic arousal (metric scale, value of 1–6) and social interaction (ordinal scale, value of 1–4) were self-rated, and greenness was calculated as the percentage of greenness in the participants' viewshed at the location of the triggered e-diary, ranging from 0 to 100%.

and living in a (sub-)urban residential area. A personal movement profile and an incentive of 50€ per participant were offered for participation through to completion. Participants had a mean age of 41.2 ± 13.2, and 52.17% were female, Table 1 depicts the characteristics of the study participants.

## Study design

This study implemented walking-triggered e-diaries to assess participants' affective states in everyday life during walking episodes (Kanning et al., 2022 (preprint)). We used a new AA-trigger approach not only ascertaining the subjects' affective states in everyday life but also accounting for subjective social interaction intensity and objective environmental greenness during walking episodes. This was accomplished using a study design with an interconnected technical interface between a smartphone (for electronic diaries, GPS- and transmission tower location tracking) and a hip-worn accelerometer. The two devices were coupled *via* Bluetooth, using the movisensXS-App (movisens GmbH, 2022)[1]. The accelerometer (Move 3, movisens GmbH[2]) has an internal memory card, a sampling frequency of 64 Hz, and can capture movement acceleration and body positions within a range of ±16 g (movisens GmbH[2]). Furthermore, the Move 3 has the advantage of being validated for documenting body positions and movement acceleration (Anastasopoulou et al., 2014; Giurgiu et al., 2020). The e-diaries were programmed to only be triggered upon several conditions: (1) Whenever movement acceleration exceeded a predetermined threshold (movement acceleration > 0.1 g for at least 1 min); (2) participants' location was identified as non-stationary (i.e., a 100 m radius of a central position was left). If conditions were met, the cell phone vibrated, made an acoustic sound, and displayed a prompt to fill out e-diaries. Prompts remained active until the participant answered or actively rejected answering (if not rejected: Sound/vibration duration: 10 s; display duration: 50 s; number of alarms/reminder: 5; maximum delay time: 20 s). It took about 1 min to fill out the prompted questionnaires. Data was collected between 6 am and 10 pm.

## Procedure

After participants finished the online questionnaire and opted in for participation in the AA, an initial phone call to reassure their wish to participate in the study was done. Participants received oral and written information regarding the study procedures before written informed consent was obtained. Full ethical approval for this study as part of the AMbit project was obtained from the University of Konstanz (IRB18KN010–004, October 29, 2018). Next, participants were contacted again *via* telephone on the day their personal package with study items (smartphone-sensor combination) was sent to them. Moreover, participants were instructed on how to use the study smartphone and accelerometers. In addition, the phone call was used to provide the individuals with further information about the approximate arrival of their study items, general information, how to access the introduction/usage video, and contact/support options. The monitoring period usually started on Monday and was conducted for nine consecutive days, to collect data on both weekdays and weekends (the first and the last day were not included in the analysis, resulting in seven consecutive days ultimately being included in the analysis). Participants were required to carry the study items with them at all times while being awake, aside from non-compatible activities (e.g., sleeping, showering, swimming). After completion of the study, the participants sent the study items back and received the incentives, along with a personal movement profile.

## Data processing

After the study, we checked for and excluded incomplete data (i.e., technical problems and missings like ID unassignable: *n* = 8, no GPS-data: *n* = 5, accuracy >20 m and no street network point available: *n* = 11). Ultimately, the data of 46 participants remained eligible for inclusion in the analysis. In the next step, the raw acceleration data from the Move 3 were downloaded and implemented in the manufacturer's data software 'DataAnalyzer'

1 https://www.movisens.com/en/products/movisensXS/

2 https://www.movisens.com/en/products/

(v.1.13.5; 1.13.7; movisens GmbH[3]). Next, data were processed in 1-min intervals by the software, and a bandpass filter (0.25 to 11 Hz) automatically removed unwanted data components (i.e., gravitational components, artifacts, sensor shocks, etc.). Non-wear time (wear-time < 7 days, < 8 h per day) was identified *via* the aforementioned software and reassigned as missing values (NAs). In the next step, the e-diaries and GPS data from the smartphones had to be allocated to the concomitant accelerometer data. This was done by uploading the smartphone data to the movisensXS browser-APP, where it was processed, and downloaded, to merge the smartphone and accelerometer data with the manufacturer's software 'DataMerger' (v.1.8.0; movisens GmbH[3]). After merging the different data into the final combined dataset, it was implemented in R (R Core Team, 2021) and RStudio (RStudio Team, 2021) for statistical data analysis.

# Measures

## Momentary affective states

To assess affective states, a shortened version of the Multidimensional Mood Questionnaire was used (Steyer et al., 1997). The scale was developed and validated for use in AA studies and homogeneity of the scale items was evaluated by Wilhelm and Schoebi (2007) for both within- and between-subject levels and satisfactory internal consistency attested. It measures affective states with three dimensions (valence, calmness, energetic arousal). Further, the scale consists of 2 items per dimension that are ordered as semantic differentials and measures the intensity of the affective states (i.e., for valence: unwell-well, discontent-content; for calmness: relaxed-tense, calm-agitated; and for energetic arousal: tired-awake, without energy-full of energy). Participants answered the triggered prompts ("At this moment, I feel…") on a 6-point-Likert scale with a left- (e.g., 1 - unwell) and right extreme (e.g., 6 - well), and the score for each dimension was derived by averaging the corresponding item scores. Using the aggregated data across the participants, Cronbach's alpha was computed for each dimension, resulting in a value of 0.85 for valence, 0.86 for calmness, and 0.81 for energetic arousal in this study.

## Social interaction

To collect data on social interaction, we developed an instrument to assess social interactions in daily life: It is based on the taxonomy of social activities from Levasseur et al. (2010) who propose 6 proximal to distal intensities of social activities, based on the concomitant goal: i.e., (1) doing an activity in preparation for connecting with others, (2) being with others, (3) interacting with others without doing a specific activity with them, (4) doing an activity with others (5) helping others, and (6) contributing to society (Levasseur et al., 2010). Since this study is researching affective states of individuals in situations of walking episodes, we decided to modify the taxonomy to better fit the circumstance of walking by describing the magnitude of interactions of the participants in 4 ascending intensities: (1) doing an activity alone (walking); (2) being with others (alone but with people around, i.e., someone is at least in sight); (3) interacting with others (social contact) without doing a specific activity with them (e.g., greeting someone); (4) doing an activity with others (we assume that an individual interacts with another when walking together). Figure 1 depicts an overview of the 4 intensities and the conditions for each.

## Greenness

The greenness was determined *via* GIS as a percentage of the green and blue areas within the potential viewshed of the participants (= the area visible by a participant from a corresponding location) at the location of a triggered e-diary (= observation). In the first step, the trigger points were filtered and corrected in terms of location: Only locations within the city of Stuttgart with an accuracy of fewer than 20 m were included in the analysis. High accuracy of the location data is required for the calculation of the viewshed. If the location is too imprecise, buildings, for example, can significantly influence the viewshed. These observations were relocated to the nearest point of the street network of OpenStreetMap (OSM[4]) (maximum 30 m; OpenStreetMap contributors, 2015). The next step was to create a surface model to determine the viewshed. Chaix (2018) recommends focusing on a small scale (50 m or 100 m), which represents a viewshed. We pushed it forward and calculated a potential viewshed (Chaix, 2018; see also Tost et al., 2019). The viewshed of each location of the questionnaire (GPS) is bounded by buildings and the topography. The buildings from OSM were given a height of 8 m and were converted to a raster image. The European Digital Elevation Model was bilinearly resampled to 50 cm. The values of both raster images were added. Based on the position-corrected location and the surface model, a potential viewshed was calculated using the software ArcMap[5] 10.6.1 by ESRI[6] (ESRI, 2010). The maximum distance of sight is 100 m (Labib et al., 2020; Boakye et al., 2021). Smaller gaps within the viewshed, which were caused by the edges in the elevation model, were filled. The green areas (grassland, forest) including water bodies were extracted from a land cover classification based on

3 https://www.movisens.com/en/products/

4 https://www.openstreetmap.org/

5 https://www.esri.com/de-de/arcgis/products/arcgis-desktop/resources

6 https://www.esri.com/

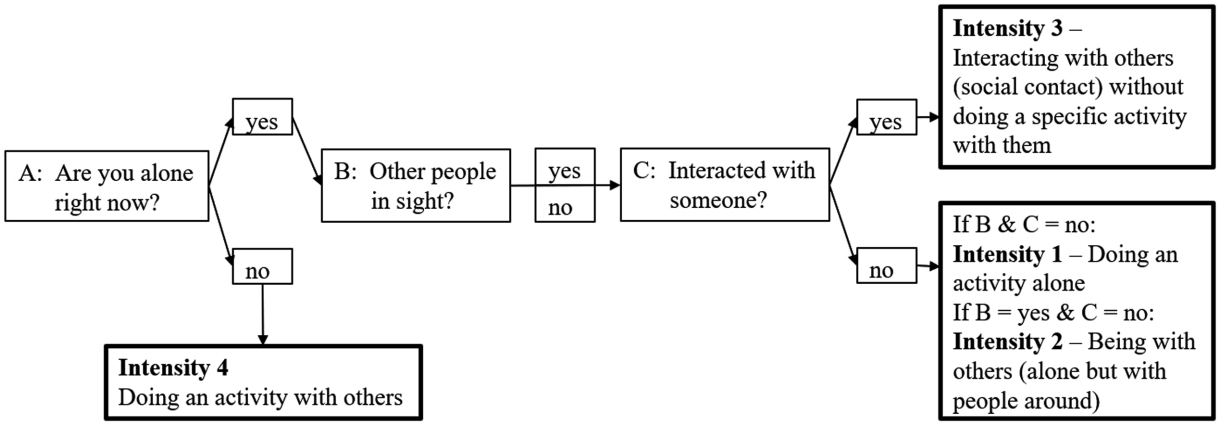


FIGURE 1
Overview of the 4 (in magnitude ascending) social interaction intensities (intensity 1–4) that are based on the taxonomy of social activities from Levasseur et al. (2010). Boxes with regular contour strength depict the prompted questions (A, B, C) and concomitant answer options, upon which the social interaction intensity was determined (bold boxes) (own depiction).

Sentinel-2 data[7] for the year 2020 with a 10 m × 10 m resolution (data license by-2-0, own calculation; mundialis GmbH & Co. KG, 2020). The classification was developed within the incora project (see BMVI, 2018).[8] This classification that we used was the closest classification to the time of data collection, as participants were recruited from July 2020 until December 2020. It consists of the following landcover classes: forest, low vegetation, water, built-up, bare soil, agriculture (mundialis, 2021[7]). Each pixel is completely assigned to one landcover class and we used forest, low vegetation, and water as green and blue spaces. The sum of all 391 viewsheds included in the analysis is 4.373 $km^2$. Of these, 2.371 $km^2$ are made up of built-up, bare soil, and agriculture combined, 0.908 $km^2$ are covered by forest, 1.091 $km^2$ by low vegetation, and 0.003 $km^2$ (or 0.17%) by water. The proportion of greenness results from the proportion of the viewshed that is covered with greenspace (mean: 33.79%, min/max: 0–100%; SD: 32.17). Labib et al. used a similar approach by using a digital surface model, a digital terrain model, and a land cover map to estimate greenness visibility (Labib et al., 2020). Figure 2 depicts the study location, the locations of the triggered questionnaires, and the types of land coverage.

## Covariates

The covariates for this study are derived from a self-report online questionnaire (comp. Recruitment and selection of study participants), which the participants filled out prior to the start of this study. Covariates consisted of participants' demographics, i.e., age, sex, and educational level. The covariates age and sex were included in the models and also used to check for cross-level interaction effects (educational level was not included as over 80% of the study sample had at least a higher school certificate).

## Data analyses

To analyze the between- and within-subject relationships between affective states, social interaction intensities, greenness, along with the cross-level interactions with the covariates, the hierarchical structure of the data must be considered. It is important to mention that the data are not independent, but dependent. Thus, multilevel modeling (MLM) instead of regular regression was implemented. MLM has several advantages, for example, it is especially suited for experimental studies with repeated measures, allows incomplete data to still be included in the analysis, and allows examining nested observations (for more information, see Hoffman and Rovine, 2007). In this study, the repeated measurements of the affective states, social interaction intensities, and greenness represented level 1 (situation-level) and were nested within the participants (person-level), representing level 2. Mixed-effects multilevel modeling with restricted maximum likelihood (REML, iterative process) estimations was implemented using R and the corresponding lmer() function from the lme4 package (alpha level $p < 0.05$). Tables for reporting the findings of the final models were generated using the 'sjPlot' package (Lüdecke, 2021).

To investigate our hypotheses for each of the three affective states, we conducted separate series of multilevel models in the following step-up approach: First, a null model was conducted, and the variance components were extracted to check for intraclass correlation coefficient (ICC), determining how much of the variation is explained by between- vs. within-person level. Next, the predictors were added consecutively at the situational

7 https://www.mundialis.de/en/deutschland-2020-landbedeckung-auf-basis-von-sentinel-2-daten/
8 https://www.bmvi.de/SharedDocs/DE/Artikel/DG/mfund-projekte/incora.html

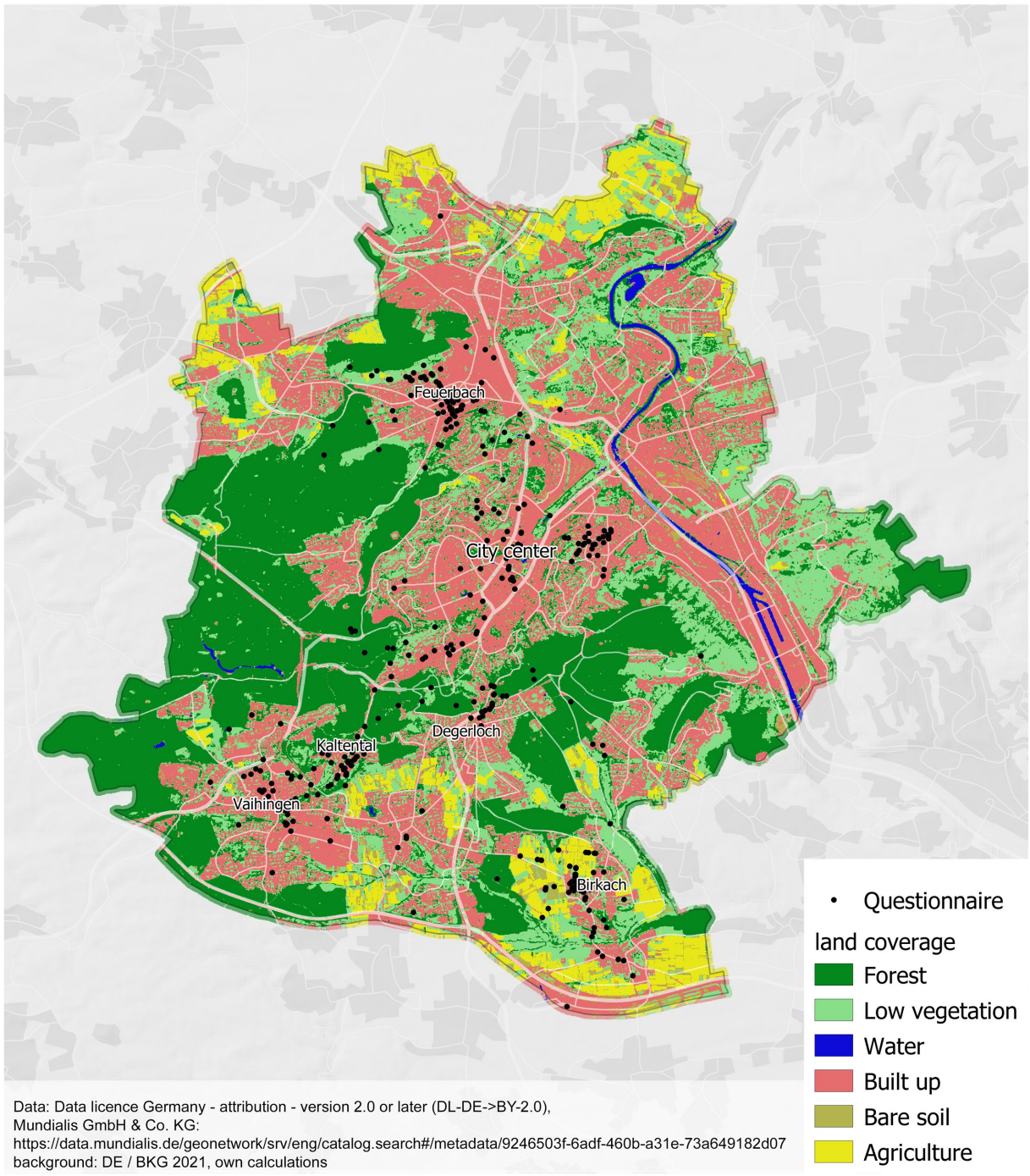


FIGURE 2
Study location, questionnaire locations, and the types of land coverage.

level, to test the direct effects of social interaction intensities (SI) and greenness (Green) on the affective states. Next, we tested whether random slopes significantly improve the model fits. Finally, the control variables (Sex and Age) and interaction terms (SI*Green) were added consecutively to each of the three affect models to further test our hypotheses. Note: As neither adding random slopes nor adding the interactions improved the model fit, they were both excluded from the equations depicted below.

In sum, this led to the following equations (the final equations depict the for all outcome variables best model, a random intercept, fixed slope model):

Level 1: $$Y_{ti} = b_{0i} + b_{1i}(SI) + b_{2i}(Green) + r_{ti} \quad (1)$$

Level 2 (Intercept): $$b_{0i} = \gamma_{00} + \gamma_{01}(\mathrm{Sex}) + \gamma_{02}(\mathrm{Age}) + \mu_{0i} \quad (2)$$

On level 1 within-participant effects are calculated. (E1) shows the response of a participant (subscript$_i$) for either of the three subscales ($Y_{ti}$) for any e-diary case (subscript $_t$). The average intercept of one subscale of affective states for all participants ($b_{0i}$) and the predictors from the situation level (level 1) is depicted as $Y_{ti}$. The predictors are group-mean-centered with "group" referring to a participant. This enables disaggregation of between- and within-subject effects (Raudenbush and Bryk, 2002). $r_{ti}$ represents the level 1 (situation level) random error. On Level 2 between-subject effects are assessed, and the fixed-, and random effects and covariates (sex, age; grand-mean-centered) are included. $\mu_{0i}$ is the level two random error. Similar to the level 1 random error, the assumption for the random error of level 2 is to be multivariate and normally distributed (expected values of "0" for both). Moreover, all non-significant effects ($p > 0.05$) of the different models were removed to clarify the result presentation.

Furthermore, the level 1 predictors (SI, Green) were standardized, to interpret the degree of their effects on valence, calmness, and energetic arousal, respectively. In addition, as SI was a four-category predictor and to enable interpretation, it was dummy coded: intensity 1 of SI as the reference category, to discriminate and compare situations where participants were alone vs. intensity 2, 3, 4 of SI, which represent situations in which participants experienced social interactions with ascending intensity (Yaremych et al., 2021). This resulted in three dummy variables (intensity 2 = D1, intensity 3 = D2, intensity 4 = D3), depicted in the equations summed as SI for easier reading. The standard deviations were retrieved from the mean of the sample for every predictor from level 1 as well as from the averaged within-participant mean of valence, calmness, and energetic arousal, respectively.

# Results

## Descriptive statistics

The 46 Participants ultimately provided a total of 391 observation data points: Walking-triggered e-diaries revealed 1840 prompts in total, of which 1,206 have been answered, resulting in a compliance rate of 65.5%. However, data condition criteria resulted in a reduction of data usable in the analysis. Note that the majority of data reduction was unavoidable because of the necessity of valid GPS data needed for the determination and calculation of the viewshed green. Also note that the analysis and result presentation is focused on greenness only and not blue spaces. We did not conduct a separate analysis for the blue spaces as only 0.17% (i.e., 0.003 km$^2$) of all green and blue spaces in the participants viewsheds in the respective trigger situations were actual blue spaces. We included the few data regarding blue spaces as greenness, because they have similar and comparable associations with mental health (Claßen and Bunz, 2018) (for more information see section 'Greenness'). Data reduction occurred due to the following: observation points with GPS: 758; GPS accuracy <20 m: 519; within city-boarders: 471; street network range < 30 m: 470; no allocation possible between online questionnaire and AA participants: 391. Ultimately an average of 8,5 e-diary entries per subject per assessment period of 7 days were available (min = 1, max = 48, SD = 10.55). The ICC for valence, calmness, and energetic arousal were $\rho_I = 0.43$, $\rho_I = 0.48$, and $\rho_I = 0.56$, respectively, indicating that 57, 52, and 44% of the variation were caused by within-person level. The variables' distribution fit the requirements for multilevel analysis. The descriptive statistics for all the variables that have been used in the analysis can be found in Table 1. Note that while not explicitly including walking episodes in the analysis, in 373 of the 391 cases included in the analysis, the following amount of steps were recorded in the 180 s prior to the prompts per participant: mean = 193.27, SD = 95.46. In addition, fixed and random effects of all three subscales of momentary affective states are depicted in Table 1. Next, the main effects of the covariates are described for each subscale of affect separately.

## Affect subscale valence

The following results from the best fit model can be reported (Table 2): Regarding the social interaction intensities during walking episodes, valence was not significantly predicted by the intensities of social interaction participants indicated (D1: $p = 0.41$; D2: $p = 0.24$; D3: $p = 0.17$). This is contrary to our expectations, i.e., no matter the intensity of indicated interaction, participants did not show higher values of valence. Also contrary to our expectations, greenness was not a significant predictor of valence ($p = 0.71$). Furthermore, no interaction effects were found between social interaction intensities and greenness, and none between the fixed effects and the covariates. No differences were found concerning age and none between men and women.

## Affect subscale calmness

Calmness (see Table 3), in accordance with our assumptions, was significantly predicted by both social interaction intensities and greenness during walking episodes, with both a higher intensity of interaction and more greenness resulting in participants indicating to be more calm. But, not all three social interaction intensities showed significant associations, i.e., compared with situations in which participants were alone or interacted shortly with someone (D1: $p = 0.34$; D2: $p = 0.24$), they felt calmer when walking together with someone (D3): The effect for D3 shows that participants, who interacted with someone while walking had a 0.16 ($p = 0.02$) points higher score for calmness than those persons who did not interact. Regarding greenness, an increase of 1 SD of greenness led to an increase in calmness of 0.09 ($p = 0.01$), i.e., more calm participants. Similar to subscale valence, no significant interactions were found.

Furthermore, no difference between men and women, and none regarding age were identified regarding the level of calmness, and none for the level 1 effects of the predictors.

## Affect subscale energetic arousal

During the examined walking episodes, both the intensities of social interaction and greenness significantly predicted energetic arousal (see Table 4). But, in this case, the comparison showed a significant association between a different intensity level with energetic arousal: Specifically, the effect for D2 shows that participants, who interacted shortly with someone during their walk had a 0.13 ($p = 0.02$) points higher score for energetic arousal than those who did not interact at all or those who interacted with someone while walking (D1: $p = 0.22$; D3: $p = 0.19$). Regarding greenness, the results show that an increase of greenness of 1 SD led to an increase in energetic arousal of 0.08 ($p = 0.02$), indicating more energized participants. In accordance with the other momentary affective state dimension, we found no significant effects regarding the interactions of the predictors. Last, as for Valence and Calmness, no differences were found between women and men.

TABLE 2 Multilevel-model analysis results for the associations of social interaction intensity (D1-D3) and greenness (Green) on the affective state dimension valence.

**Valence**

| Predictors | Estimates | std.Beta | CI | Standardized CI | *p* |
|---|---|---|---|---|---|
| (Intercept) | 0.52 | −0.07 | −0.03–1.07 | −0.31–0.16 | 0.064 |
| D1 | −0,10 | −0.05 | −0.35–0.14 | −0.18–0.07 | 0.412 |
| D2 | 0.15 | 0.07 | −0.10–0.41 | −0.05–0.20 | 0.247 |
| D3 | 0.16 | 0.10 | −0.07–0.40 | −0.04–0.25 | 0.170 |
| Green | 0.00 | 0.02 | −0.00–0.00 | −0.07–0.10 | 0.715 |
| Sex | −0.34 | −0.20 | −0.71–0.03 | −0.41–0.01 | 0.068 |
| Age | 0.01 | 0.21 | −0.00–0.03 | −0.00–0.42 | 0.051 |
| Random Effects | | | | | |
| $\sigma^2$ | 0.41 | | | | |
| $\tau_{00Participant}$ | 0.27 | | | | |
| ICC | 0.40 | | | | |
| $N_{Participant}$ | 46 | | | | |
| Observations | 391 | | | | |
| Marginal $R^2$/Conditional $R^2$ | 0.096/0.454 | | | | |

Standardized, (std.); Beta, β; CI, 95% confidence intervals; (p), the level of significance; $\sigma^2$, within-person variance; $\tau_{00Participant}$, between-person variance; ICC, intraclass correlation coefficient.

TABLE 3 Multilevel-model analysis results for the associations of social interaction intensity (D1-D3) and greenness (Green) on the affective state dimension calmness.

**Calmness**

| Predictors | Estimates | std. Beta | CI | Standardized CI | *p* |
|---|---|---|---|---|---|
| (Intercept) | 0.20 | −0.04 | −0.44–0.84 | −0.31–0.23 | 0.540 |
| D1 | 0.12 | 0.06 | −0.12–0.36 | −0.06–0.19 | 0.340 |
| D2 | 0.15 | 0.07 | −0.10–0.40 | −0.05–0.20 | 0.247 |
| D3 | 0.26 | 0.16 | 0.03–0.50 | 0.02–0.31 | 0.029 |
| Green | 0.00 | 0.09 | 0.00–0.01 | 0.02–0.17 | 0.019 |
| Sex | −0.07 | −0.04 | −0.50–0.35 | −0.28–0.20 | 0.728 |
| Age | 0.01 | 0.11 | −0.01–0.02 | −0.13–0.34 | 0.386 |
| Random effects | | | | | |
| $\sigma^2$ | 0.40 | | | | |
| $\tau_{00Participant}$ | 0.40 | | | | |
| ICC | 0.50 | | | | |
| $N_{Participant}$ | 46 | | | | |
| Observations | 391 | | | | |
| Marginal $R^2$/Conditional $R^2$ | 0.026/0.509 | | | | |

Standardized, (std.); Beta, β; CI, 95% confidence intervals; (p), the level of significance; $\sigma^2$, within-person variance; $\tau_{00Participant}$, between-person variance; ICC, intraclass correlation coefficient.

TABLE 4 Multilevel-model analysis results for the associations of social interaction intensity (D1-D3) and greenness (green) on the affective state dimension energetic arousal.

**Energetic arousal**

| Predictors | Estimates | std. Beta | CI | Standardized CI | *p* |
|---|---|---|---|---|---|
| (Intercept) | 0.29 | 0.01 | −0.44–1.01 | −0.24–0.26 | 0.437 |
| D1 | 0.16 | 0.07 | −0.09–0.41 | −0.04–0.17 | 0.220 |
| D2 | 0.31 | 0.13 | 0.05–0.57 | 0.02–0.23 | 0.021 |
| D3 | 0.16 | 0.08 | −0.08–0.41 | −0.04–0.21 | 0.191 |
| Green | 0.00 | 0.08 | 0.00–0.01 | 0.01–0.15 | 0.022 |
| Sex | −0.20 | −0.09 | −0.67–0.28 | −0.32–0.13 | 0.418 |
| Age | 0.02 | 0.21 | 0.00–0.04 | 0.01–0.43 | 0.067 |
| Random effects | | | | | |
| $\sigma^2$ | 0.43 | | | | |
| $\tau_{00Participant}$ | 0.52 | | | | |
| ICC | 0.55 | | | | |
| $N_{Participant}$ | 46 | | | | |
| Observations | 391 | | | | |
| Marginal $R^2$/Conditional $R^2$ | 0.082/0.585 | | | | |

Standardized, (std.); Beta, β; CI, 95% confidence intervals; (p), the level of significance; $\sigma^2$, within-person variance; $\tau_{00Participant}$, between-person variance; ICC, intraclass correlation coefficient.

## Discussion

This study aimed to examine associations between social- and physical environmental factors and affective states during walking episodes in urban areas. In addition, we implemented an innovative AA approach, using a combination of GPS- and walking-triggered e-diaries to identify situations of walking episodes. Concerning the hypothesized associations of this study, mixed findings were reported with the following implications:

Contrary to our hypothesis, the affective state of valence was not significantly associated with the intensity of social interaction. This is not in line with findings from Bernstein et al. (2018), who used a study design with 6 semi-random prompts per day over three days upon which participants indicated social interaction and the pleasantness of that interaction, showing more happiness in situations with social interactions. Another study by Monninger et al. (2022) linked social interactions to higher positive affect, but instead of asking the participants "live" in the situations, they indicated the number and quality of social contacts in the last 2 h prior to a prompt. It follows that the three approaches produce different findings, which leads to questions about the eligibility of the different assessment methods and the comparison of findings. Also contrary to our predictions, no association between valence and greenness in the situations in which e-diaries were triggered was found. A possible explanation for this finding could be that the exposure to greenspace was only measured as a percentage of surrounding green right in the moment of the triggered e-diary. This amount of green can often be little compared to a cumulative greenspace exposure that sums up the amount of green along a walking route or a certain time-span, and thus might not be "enough" to have an effect on individuals' valence. For example, Tost et al. (2019) did find higher valence ratings for participants that were surrounded by a lot of urban vegetation by analyzing viewshed green, greenspace exposure 5 min prior to a valence rating, as well as exposure to green over the course of a week. Furthermore, the results show that regarding valence neither the effect of intensity of social interaction nor that of greenness depend on each other, as their interaction did not show any significant associations with valence.

Most strikingly, and confirming our hypothesis regarding the affective subscale calmness, our results show significant independent associations with both social interaction intensity and greenness during walking episodes. To be precise, participants, who walked together with someone during their walk (= D3), and those who were walking in a greener environment, indicated to be more calm/relaxed. This association between walking together with someone (= D3) and calmness can be explained by a calming/relaxing and supportive effect of being and interacting with someone familiar. Supporting this, e.g., Smyth et al. (2014) found social support to decrease negative mood and to predict less stress severity, and in addition, Schwanen and Wang (2014) also found a positive effect of (close) social contacts (e.g., friends, companions) during activities on wellbeing. The finding that more environmental green was associated with more calm/relaxed individuals' is in line with the finding of Nutsford et al. (2013), who found that both observable and usable greenspace in urban environments can protect against mood and anxiety disorders. This indicates that people who live in urban environments that are often characterized by negative environmental influences and stimuli like (traffic-) noise, or dull and monotonous surroundings, profit from both social interactions and greenness by helping individuals to remain- or calm down and be more relaxed. As urban populations continue to grow, such calming effects of the social- and physical environment may help to mitigate overstimulation and ultimately aid as protective factors. Also, as for valence, the interaction of greenness and social interaction level did not show significant associations with calmness. This indicates that these effects might not need to co-occur. However, future studies are needed to research these aspects further.

Regarding the third affective state dimension energetic arousal, we also found significant independent associations, with both a higher intensity of social interaction and more greenness resulting in increased energetic arousal. One might conclude that the identified calming effect of both social interactions and greenness as presented for calmness could mitigate higher arousal levels and thus be counterintuitive to these results, but the following has to be considered: First of all, the momentary affective states scales are semantic differentials (compare with section 'measures'), i.e., being 'relaxed' (calmness) does not mean being 'tired' (energetic arousal), or being 'calm' does not mean, a person is not full of energy. Thus, a person that feels relaxed in a (green) environment can still be tired or awake. Also, on the one hand, contrary to the findings for calmness, only situations, in which subjects were walking outside and had a short interaction with someone (= D2) were significantly associated with energetic arousal. That implies that a more sudden, unexpected interaction has more of an effect on energetic arousal, compared to a calming/relaxing effect when walking with someone familiar (= D3). On the other hand, supporting evidence for the finding of increased energetic arousal after a short walking bout stems from Reichert et al. (2017), who showed that already non-exercise activity increases energetic arousal. Thus, even though Reichert et al. (2017) investigated a time span of 15 min vs. the 100 m and approximately 1–2 min span in our study, we can report similar findings. Next, the finding that more greenness in the participants' viewshed led to an increase in energetic arousal can be seen as a consequence of individuals feeling awake, and energized when being in a more green environment, compared to more dull experience in environments with no or less environmental green (= urban areas). Supporting evidence comes from Beute and de Kort (2018), who implemented an ecological momentary assessment to assess how nature (and daylight) effect affect and stress of subjects with and without depression and who found positive associations between the exposure to nature (and daylight) and energy levels. In another study, Markevych et al. (2017), attest greenspace restoring capacities, i.e., greenspace helps to reduce stress, restore attention, and elicit positive emotions in general. But, concerning the small effect of greenness, implications have to be considered with caution, as a stronger effect was expected with regard to findings from other studies (e.g., compare McMahan and Estes, 2015). In future steps, a combination of prompts at the beginning of a walking bout and after several minutes may provide further insight into time-dependencies of the effect of social interactions and greenness on energetic arousal levels.

By implementing a new study design with walking-triggered e-diaries, a novel approach to measure social interactions, and additionally enriching the assessed data with subsequently imputed environmental data, we were able to collect data regarding environmental factors and their association with momentary affective states in walking situations. The knowledge about the feasibility of this data assessment method should be used to collect further data in different residential environments. Also, these assessments should include additional environmental factors (e.g., noise, blue spaces), and PA measures to control for the role PA plays in these associations and to increase the informative value of the results of this study and also, to continuously improve data collection methodology. Besides our study design being feasible, several limitations have to be considered. First, only data from 46 participants, and a total of 391 measurements were included in the analysis, which is a comparatively low number for multilevel analysis. But, calculating the viewsheds instead of simple buffers requires a higher accuracy of the GPS signal. In our analysis, we used a GPS accuracy of at least 20 m. As a consequence, data with a lower accuracy was lost. Within built-up areas, GPS accuracy decreases because tall buildings affect the GPS receiver's contact with the satellites. For example, Schipperijn et al. (2014) report an average accuracy of 11.5 m while walking within urban canyons, with a standard deviation of 14 m. Second, we did not apply multiple testing correction for the *p*-values, which could theoretically lead to the by chance discovery of significant results; however, as our design is experimental, to do no correction is reasonable (Goeman and Solari, 2011). Also, as is often the case, our study sample consisted of 81% individuals with a high education level, making generalizations difficult. Third, future studies should consider combining the present research approach with the additional inclusion of measurements of blue spaces, if such data is present in the respective locations, as blue spaces have been shown to have comparable positive associations with individuals wellbeing and mental health and thus might add important information (Kistemann and Völker, 2014; Grellier et al., 2017; Claßen and Bunz, 2018). Also, future studies should consider to investigate greenness and social interaction in inactive outside-of-home episodes to compare environmental influences on affective states in active vs. non-active situations. Fourth, albeit no severe restrictions like curfews being in place during the time of data collection, data were collected during the Covid-19 pandemic, which led to many changes in individuals' daily lives and routines, which could hinder comparability. Also, to identify, whether long-term exposure to certain social- and physical environments leads to the development of chronic conditions, it is necessary to combine short-term data collection (i.e., days, weeks) with long-term data collection (i.e., months, years; Chaix, 2020). Furthermore, with the secondary environmental data used in this study, we cannot specify what kind of green exactly led to the observed effect. That is, we cannot determine that the effect of greenness actually stems only from the context of a green environment, i.e., the observed effect might actually also come from other confounding factors like bird noise or a calm environment and may as well depend on weather conditions and not only on the environmental green itself. Thus, future research should try to incorporate measurement methods that can more specifically identify an effect of green itself and should account for the weather conditions as well.

To conclude, we were able to implement a new data assessment method that allows accounting for social- and physical environmental factors and their impact on momentary affective states right in the corresponding situations in which they are present. Usage of the assessment method of this study together with the findings from this study can aid decision-makers regarding the creation and design of more healthy and livable residential areas. Also, our results support the calls from different research fields for stronger incorporation of social- and environmental factors when planning, designing, and evaluating ways to promote walking/active mobility and public health in urban environments.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by University of Konstanz (IRB18KN010–004, October 29, 2018). The patients/participants provided their written informed consent to participate in this study. The study fully conformed to the Declaration of Helsinki and the ethics guidelines of the German Psychological Society.

## Author contributions

LB: conception of the manuscript, analysis and interpretation of data, writing original draft, data acquisition. JS: GIS-data acquisition and data analysis, revising the manuscript. MK: overall conception and design of the study, revising the manuscript. CN: overall conception and design of the study, revising the manuscript. All authors were involved in critically revising the manuscript, and have given their approval for submitting the manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Climate change induced human displacement in Bangladesh: Implications on the livelihood of displaced riverine island dwellers and their adaptation strategies

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In Bangladesh, many people are being displaced in riverine island (char) areas every year due to climate change and its associated natural catastrophes. This study intends to investigate the impact of climate change on internally displaced char people's lives and livelihoods along with local adaptation strategies and hindrances to the coping mechanism. Data have been collected from 280 internally displaced households in two sub-districts. A mixed-method approach has been considered combined with qualitative and quantitative methods. The results disclose that frequent flooding, riverbank erosion, and crop loss are the leading causes for relocation, and social relations are impeded in the new place of residence. Increasing summer and winter temperatures, recurrent flooding, severity of riverbank erosion, and expanding disease outbreaks are also important indicators of climate change identified by displaced people, which are consistent with observed data. This study also reveals that almost all households come across severe livelihood issues like food shortage, unemployment and income loss, and housing and sanitation problems due to the changing climate associated with disasters in the former and present places. In response to this, the displaced people acclimatize applying numerous adaptation strategies in order to boost the livelihood resilience against climate change. However, fragile housing, financial conditions, and lack of own land are still the highest impediments to

the sustainability of adaptation. Therefore, along with the government, several organizations should implement a dynamic resettlement project through appropriate scrutiny to eradicate the livelihood complications of internally displaced people.

KEYWORDS

climate change perception, natural disasters, livelihood vulnerability, livelihood resilience, adaptation obstacle, internally displaced char dwellers

## Introduction

Climate change has confronted the world with huge complications and threats in the 21st century (Tajrin and Hossain, 2017). Developing countries are not exception and increasingly vulnerable due to the enhancing regularity and intensity of natural hazards (IPCC, 2014; Islam et al., 2019; Yousafzai et al., 2022). The shifting trend of temperature, rainfall, sea level rise, and the alteration of severe climate indicators are all manifestations of climate change and its consequences (Chen and Mueller, 2018; Hossain et al., 2020b). Climate change has a widespread impact on world economic, social, and political activities and disrupts the people's way of life massively (Brooks et al., 2009; Du et al., 2013; Bergquist et al., 2019). As a result, one of the myriad problems that people face worldwide is the harmful effects of climate change (Wang et al., 2019; Uddin et al., 2022). It has already been documented that climate change, which has a detrimental consequence on the lives and livelihoods of the world population, is predicted to be one of the most significant risks to economic progress of developing countries (IPCC, 2014; Tol, 2018; Wrathall et al., 2019). Natural hazards increase the number of displaced people, and climate change hastens these situations (Ahmed, 2018; Wang et al., 2020). According to Brzoska and Fröhlich (2016), the amount of environmental or climate change-induced displaced individuals is higher than political and war refugees. Furthermore, according to the IPCC (2019), climate change-related impacts could lead 150 million people to be displaced by 2050.

Bangladesh is one of the countries that are most vulnerable and imperiled to climate change due to its distinctive geographical position, brittle socioeconomic settings, expanding populace, high poverty, and low degree of financial and technological capabilities (Shahid and Behrawan, 2008). In Bangladesh, the average temperature is rising day by day, and by 2030 and 2050, the temperature will have increased by 1.0 and 1.4°C, respectively, owing to climate change (IPCC, 2014; Roth et al., 2021). In terms of extreme weather, it is rated as the fifth most susceptible state in the world. As a result, approximately every year, more or less, this country is subjected to repeated severe climate phenomena, such as floods, riverbank erosion, cyclones, saline intrusion, landslides, storm surges, and droughts (Rakib et al., 2018). It exacerbates abundant problems, including severe direct and indirect life and livelihood issues (Kabir R. et al., 2016). However, one of the most catastrophic implications of climate change is that people are being forced to flee their homes, lands, and livelihoods due to natural disasters caused by climate change (Barua et al., 2017; Islam et al., 2022). Many tens of millions of people will be displaced due to these processes in the coming years (Rahman, 2021). Bangladesh is very susceptible to the effects of climate change, which might force up to 30 million people to flee their homes by 2100 if sea levels rise to the projected 80 cm or higher (Barua et al., 2017). People who have been displaced or who have migrated suffer a severe lack of human rights facilities and fierce competition for unbiased access to wealth, as well as the effects of fast urbanization, water shortages, lack of power, hardship, and the rising intensity and occurrence of catastrophes (Goodwin-gill and Mcadam, 2017). Also, internal migration or displacement can lead to conflict (Malpeli et al., 2020). On the contrary, Bardsley and Hugo (2010) recommended that internal migration be worthwhile tactics as acclimatization to contend with the rising effects of climate change.

However, in Bangladesh, char (riverine island) is one of the highly susceptible locations to climate change owing to its proximity to flood-prone rivers (Hossain et al., 2021). Char land is a type of land that forms over 2–3 years due to continual riverbank erosion and sediment deposition in large rivers and shoreline zones. This land is mainly cut off from the mainland (Karim and Thiel, 2017). This region is historically known as the most ignored and underprivileged (Emdad Haque and Zaman, 1993). Regularly, this part is highly exposed to natural calamities, such as floods and riverbank erosion (Hossain et al., 2021). Furthermore, it is estimated that around 4–5% of the populace of Bangladesh lives in the char land. Most char households are directly or indirectly involved in agriculture (Hossain et al., 2019). Households living on islands are thought to be the highly exposed to the effects of climate change (Shah et al., 2013). Climate change-associated disaster is destroying their crops, farmland, and houses. Char inhabitants are more defenseless, highly poor, and food uncertain due to these distinctive characteristics. Because char dwellers have restricted access to essential requirements, including food, agriculture, education, health, and finance, they are more prone to become

impoverished. Every year, the char dwellers face extreme climate change-related threats, such as floods, riverbank erosion, and drought. As a result, these climate change-related push factors induced huge displacement among the char dwellers.

Therefore, it is documented that the displaced people are confronted with massive complications regarding lives and livelihood after being displaced to a new place from their ancestral location (Elshater, 2021). The significant climate change-induced impact on various livelihood assets is rising day by day (Hossain et al., 2020a). Paudel (2010) stated that food uncertainty and malnutrition had increased massively due to the lack of work opportunities in the new places. In addition, extreme climate events have increased various common diseases, such as cold and cough, fever, headache, heart stock, mental disorders, back pain, energy loss, breathing problems, and tonsil (Haque et al., 2013). In addition, housing and sanitation issues, deterioration of social relations, and so on lead to overwhelming consequences after being displaced in a new location (Hossain et al., 2020a). For this reason, this study has been concentrated on the char dwellers displaced in a new location. A majority of these people are dwelling under ultra-poor conditions, including a low level of income and occupation. It is well known that catastrophes disproportionately affect the underprivileged (Penning-Rowsell et al., 2013), and climatic hazards are projected to wreak devastation on these individuals the most. Yet, such people do not have adequate defense strategies (Brouwer et al., 2007).

Internally displaced people (IDPs) more or less form adaptation techniques in response to the livelihood complications triggered by climate change and its associated disasters. Adaptation tactics differ from one place to another place and from one culture to another (Rahman and Hickey, 2019; Khan et al., 2020). Nevertheless, adaptation is essential for defenseless nations like Bangladesh to increase adaptive capacity and reduce societal susceptibility in the face of climate change (Ausden, 2014; Vij et al., 2018). Adaptation systems are developed based on the presence of the individuals' technological, social, environmental, economic, and physical resources. To cope with the effects of changing climate, impoverished rural communities have heavily relied on adaptation tactics. However, without a proper understanding of climate change impacts and local adaption techniques among char dwellers, the approach may not be effective in strengthening resistance to adverse effects of climate change (Tang and Hailu, 2020). On the contrary, several types of barriers, such as cultural, social, financial, environmental, and organizational obstacles, reduce the adaptability capacity and increase (Lahsen et al., 2010). Some studies detected that the scarcity of political will and harmonization among diverse institutions, insufficiency of monetary provision, restricted possessions, and paucity of awareness have all been recognized as impediments to viable adaptation (Runhaar et al., 2012).

A number of studies on climate change-associated issues, such as health, livelihood, displacement, and resettlement, including adaptation strategy, have formerly been carried out (Zaman, 1989, 1993; Pouliotte et al., 2009; Haque et al., 2013; Alam, 2017; Fang et al., 2018; Liu et al., 2020; Hossain et al., 2021). But, a very little focus has been placed on the impacts on the livelihood of IDPs caused by climate change and its associated hazards. More precisely, in the case of Bangladesh, a specific focus on the impact of climate change on lives and livelihood and adaption practices of riverine island dwellers is still lacking. As a result, this study aims to fill some of this gap by examining the impact of climate change on lives and livelihood from displaced people's perspectives and by finding local adaptation mechanisms in char district areas of Bangladesh, with particular attention to the weaknesses and limitations of their coping strategies. The number of internally displaced individuals is growing, so it is crucial to discover a way to mitigate the effects of significant climate change in riverine char districts areas of Bangladesh. Furthermore, it is crucial to know the impediments to adaption practices among displaced people's communities in disaster-prone areas to facilitate proper climate change adaptation. This study will contribute to the existing knowledge of acclimatization efforts against the consequences of climate change. In addition, it will help determine the climate change barriers to displaced dwellers' adjusting techniques in Bangladesh.

## Materials and methods

This study followed a mixed-method approach incorporating qualitative and quantitative approaches. Hence, a questionnaire survey and an interview guide were adopted for the quantitative and qualitative approach, respectively. In addition, an in-depth literature review for secondary data was carried out before collecting data.

### Study area and location

Gaibandha is one of the most natural disaster-prone districts in Bangladesh. Every year, climate-related disasters such as floods, riverbank erosion, cyclones, and other natural disasters strike this region (Islam, 2018). Furthermore, the dwellers of this area are exposed to disasters such as summer storms, floods, and riverbank erosion during the rainy season, as well as summer and spring droughts, and winter cold waves (Hossain et al., 2020a). Climate change is wreaking havoc on their crops, farming lands, and homesteads. The residents of this area are more vulnerable, highly impoverished, and food insecure as a result of these disasters. They are also more prone to fall into poverty since they have little

access to essential needs. The effects of climate change have a bad influence on their incomes and work chances (Brammer, 2014). Due to this, the lives and livelihood of the people of this region are severely disrupted every year (Sarker et al., 2019). As a result, many people are internally displaced from one place to another, which has become a regular phenomenon in this region (Hossain et al., 2020a). This is why Gaibandha district has been purposively selected for this study.

Gaibandha district is located in the Rangpur Division. It is surrounded on the north by Kurigram district and Rangpur district, on the east by Kurigram district and Jamalpur district, on the south by Bogra district, and on the west by Joypurhat district, Dinajpur district, and Rangpur district (BBS, 2011). Gaibandha district lies between 25°02′ and 25°39′ north latitudes, and between 89°11′ and 89°46′ east longitudes. The total area of the district is 2,114.77 sq. km (816.00 sq. miles) (BBS, 2011). To meet the purpose of this study, Fulchari and Saghata upazilas have been chosen purposively as the study area from the seven sub-districts (upazila) in the Gaibandha district (**Figure 1**) since this area is very adjacent to the Jamuna–Brahmaputra River basin zones.

## Sampling and data collection

The following statistical procedure was used to estimate a representative sample size for this investigation (Cochran, 2017):

$$n = \frac{z^2 \times p \times q \times N}{e^2 (N-1) + z^2 \times p \times q} = 280$$

Here, $n$ = Sample size, N = total number of households, z = confidence level (at 95% probability = 1.96, $p$ = estimated population proportion (0.5 this maximizes the sample size), $q$ = 1-p, e = error limit of 5% (0.05).

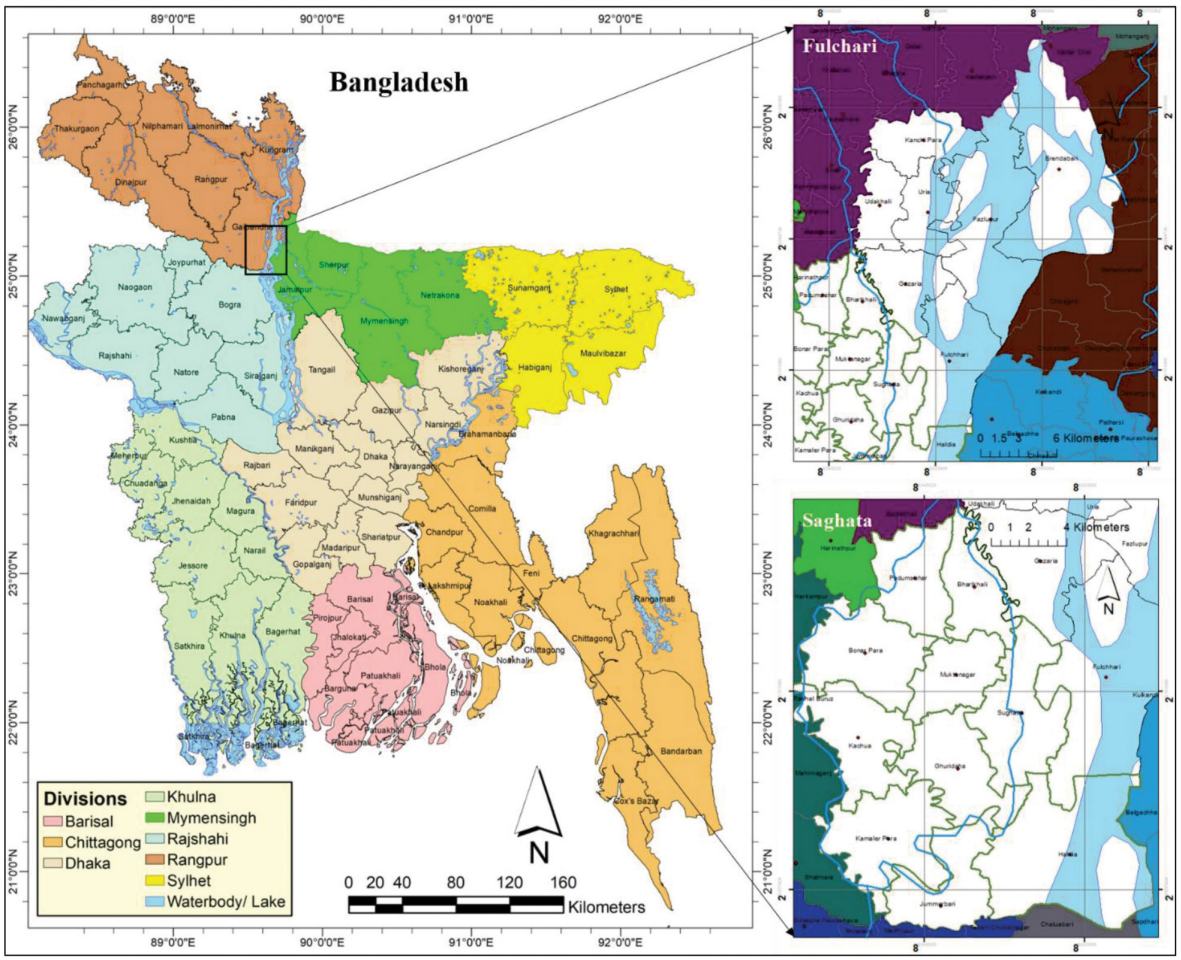


FIGURE 1
Location of the study area.

Therefore, a total of 280 internally displaced people (IDP) households (140 from each sub-district) were selected by simple random sampling among the IDP communities from the two sub-districts (total 1,029 households). The field surveys were conducted using a semi-structured questionnaire, and a pilot survey was conducted to learn the concerns to be investigated in this study. Thus, two sets of open-ended and close-ended interview questionnaires (IDPs and KIIs) were used to conduct a field survey in terms of the pilot survey, field visit, literature review, and specialist view concerning the study aims.

Therefore, quantitative data were collected from 280 IDPs by using a questionnaire survey. On the other hand, qualitative data were collected from focus group discussions (FGDs), depth interviews, KIIs, and observations. A total of six FGDs (one male group and one female group from each sub-district) were carried out, where 8–12 displaced individuals take part in each focus group discussion. In some of the cases, some of the people did not agree to interview in front of the other people, for whom depth interviews were conducted to know the actual condition of the displaced people in the study area. In addition, eight key informant interviews (KIIs) were carried out with several officials from the GO and NGO sectors concerned with climate change, migration, and IDPs along with local representatives from Fulchari and Saghata. A purposive method was applied to select the key informants experienced in climate change, natural disasters, migration, and adaptation strategies. The survey was conducted from October 2018 to March 2019.

Ethical considerations were given much attention. During the fieldwork, the researchers introduced themselves and explained the reason for their visit. Furthermore, all respondents gave their consent before the interview session, recording, or taking a snapshot of their activity. The respondents were informed of the study goal and promised that their identities would not be revealed.

## Data analysis techniques

After gathering all the data through interview sessions with the respondents, the gathered data were examined in accordance with the rationale of this study. Statistical Package for the Social Sciences (SPSS) was used to analyze the quantitative data. The univariate and bivariate analyses were carried out for the displaced people's responses in the context of climate change, migration, and acclimatization strategies, along with hindrances to adaptation in the migrated places in Bangladesh. On the other hand, the qualitative data figured out via textual and document analysis. Tables, charts, and graphs were categorized, at the same time, to make the material more pertinent and accessible to the person who reads. Furthermore, the investigators clarified in terms of the findings and observations made throughout the primary and secondary data analyses, as well as interviews with informants.

## Measurement of climate change impact and adaptation practice

The climate change impact was measured in this study through five livelihood assets, namely, human capital, social capital, financial capital, physical capital, and natural capital. In addition, several variables (**Table 4**) under the five livelihood capitals were also considered to comprehend the intensity of the climate change impact on the IDPs. Furthermore, climate change impacts on displaced people's way of life were also analyzed based on the previous and present locations. In addition, five scales such as no, slightly, medium, and large have been considered to analyze the climate change and its associated hazard impacts regarding the displaced people's lives and livelihood. On the contrary, the IDPs' acclimatization approaches for lessening climate change impacts were considered using 20 variables. Concerning this, three scales like low, medium, and high were also taken into account based on households' income patterns to explore the real scenarios of the displaced people (**Table 5**). In addition, this study found two categories of adaptation strategies, namely, (1) individual-level adaptation (ILA) and (2) planned adaptation (PA), that mainly IDPs follow to cope with the climate change impacts on livelihood (Hossain et al., 2021).

# Results

## Socioeconomic conditions of displaced people

The main purpose of this section is to understand the respondents' socioeconomic characteristics in the study areas. This part has been designed based on the socioeconomic status of individuals influenced by climate change, which is associated to their age, gender, education, main occupation, and household income, in order to get in-depth evidence about the participants.

In this study, among the entire respondents in the study area, 50% were male and 50% were female, in which a majority of the respondents were young and middle-aged. In addition, 36.07% of the respondents were illiterate, while 38.21, 14.29, and 11.43% of the participants had primary, secondary, and above the secondary level of education status. Furthermore, the respondents were engaged in several occupations in the study area, such as farmer, day laborers, housemaid, rickshaw puller, street hawker, beggar, and bricklayer service (see **Table 1**). On the other hand, **Table 1** also reveals the respondents' personal monthly income profile, where the respondent's monthly income was not good enough. Most of the respondents' monthly income was below 8,000 BDT, and only 2.5% of the respondents' personal income was above 8,000 BDT. On the contrary, 34.64 and 7.14% of the respondents' monthly income

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TABLE 1 Socioeconomic characteristics of the respondents.

| Characteristic | Scoring system | Categories | Respondents | | Mean | SD |
|---|---|---|---|---|---|---|
| | | | F | % | | |
| Gender | Code | Male (1) | 140 | 50.00 | 1.5 | 0.5 |
| | | Female (2) | 140 | 50.00 | | |
| Age | Years | Young (18–35) | 113 | 40.36 | 43.59 | 20.32 |
| | | Middle (36–53) | 127 | 45.35 | | |
| | | Old (54–70) | 40 | 14.29 | | |
| Education | Year of schooling | Illiterate (1) | 101 | 36.07 | 4.47 | 5.26 |
| | | Primary level (1–5) | 107 | 38.21 | | |
| | | Secondary level (6- 10) | 40 | 14.29 | | |
| | | Above secondary ( > 10) | 32 | 11.43 | | |
| Primary occupation | Code | Housewife (1) | 53 | 18.93 | 4.28 | 2.42 |
| | | Day labor (2) | 34 | 12.14 | | |
| | | Farmer (3) | 26 | 9.29 | | |
| | | Housemaid (4) | 33 | 11.79 | | |
| | | Rickshaw puller (5) | 41 | 14.64 | | |
| | | Street hawker (6) | 27 | 9.64 | | |
| | | Beggar (7) | 35 | 12.5 | | |
| | | Bricklayer (8) | 24 | 8.57 | | |
| | | Service (9) | 7 | 2.5 | | |
| Personal monthly income | BDT. | ≤ 2,000 | 103 | 36.79 | 3,376.79 | 2,000.00 |
| | | 2,000–4,000 | 91 | 32.50 | | |
| | | 4,000–6,000 | 49 | 17.50 | | |
| | | 6,000–8,000 | 30 | 10.71 | | |
| | | > 8,000 | 7 | 2.5 | | |
| Household monthly income | BDT. | 1,000–5,000 (low) | 97 | 34.64 | 6,298.21 | 2,712.31 |
| | | 5,000–10,000 (Medium) | 163 | 58.21 | | |
| | | > 10,000 (High) | 20 | 7.14 | | |

Field survey (1 USD = 95 BDT).

were 1,000–5,000 BDT and above 10,000 BDT, respectively. But the majority (58.21%) of the monthly household income was 5,000–10,000 BDT.

## Drivers of prompting displacements from ancestral place

This section depicts the drivers and factors of displacement of riverine island dwellers from their ancestral locations. This study revealed that six drivers, namely, environmental, social, economic, physical, psychological, and political drivers, induced displacement behavior of the char dwellers enormously (Figure 2). Climate change and its associated disasters like flood and erosion are the significant influencing drivers and factors of displacement. The FGDs unfolded that loss of agriculture, unemployment and income loss, damage of homestead, scarcity of food, freshwater crisis, problem of sanitation, and less educational opportunity were the most important causes for being relocated from their ancestral locations.

In addition, qualitative findings revealed most respondents were displaced from a riverine island located in Fulchari and Saghata upazilas of Gaibandha district. These zones are highly vulnerable to frequent flood disasters, riverbanks, and other natural calamities. Every year, many people lose their assets, including land, livestock, and way of living options, owing to the implications of several natural catastrophes, especially riverbank erosion caused damage at an enormous scale. For example, substantial loss of properties and harm to living opportunities were detected owing to flood events in 2017. A respondent stated his/her opinion in this regard as follows:

> *"I and my family were decided that not to leave our ancestral homestead at any cost in the face of natural calamities' damages because we thought that we wouldn't confront any significant issues. But after 2 years later, we encountered an overwhelming 2017 flood disaster in our living area, and finally, we had to leave our home due to lost our homestead land caused by the river erosion. We not only faced this problem alone but also our neighbors met the same problem.*

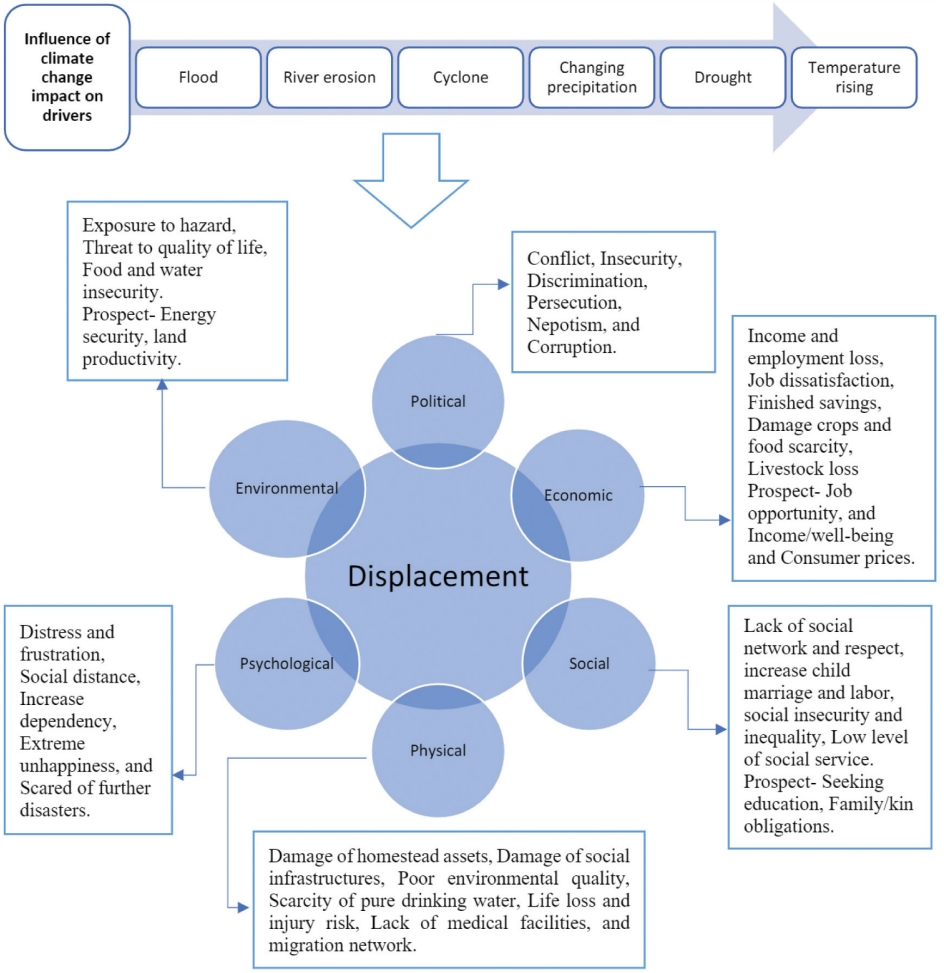


FIGURE 2
Drivers and factors of displacement from riverine island areas in Bangladesh.

> *Since we are a poor man, therefore, we were no bounds of sorrows in our life after being forced displacement from our home, which made us more vulnerable" (Interviewee #59).*

## Conditions of civic amenities in the prior and present locations

Table 2 demonstrates the displaced people's opportunities and further civic amenities in former and current places. After the resettlement, the displaced people were confronted with the actualities of various social circumstances and amenities in the dwelling area.

The displaced people reported their opinion concerning different forms of opportunities and other civic amenities; almost half of the respondents revealed that communication system was very bad in their previous dwelling places. Still, 67.5% of respondents stated that the communication system is good in the present location. Also, respondents shared that sanitation amenities, drinking water, healthcare services, education opportunities, and flood shelter were comparatively good in the present location. On the contrary, a majority of the respondents (78.57%) stated that their social network was relatively good in the previous location. Concerning this, a respondent narrated his/her opinion as follows:

> *"We are a poor man living in an underdeveloped place, where we could not arrange a minimal level of family affairs every day. But we were relatively lived there unitedly and tried to share our grief with the relatives and neighbors. But climate change and its associated hazards kicked us different places. As a result, our social network has somehow reduced, and we feel lonely after being displaced from our previous position. As well, we are experiencing some problems while managing our lives" (Interviewee# 13).*

TABLE 2 Opportunities and other civic amenities in prior and current locations.

| Amenities | Condition | Very good | Good | Neither good nor bad | Very bad | Bad | Comment |
|---|---|---|---|---|---|---|---|
| Communication system | PvC | – | 5.36 | 14.64 | 51.07 | 28.93 | + |
| | PsC | 19.29 | 67.5 | 10.00 | – | 3.21 | |
| Sanitation amenities | PvC | – | 12.14 | 14.29 | 45.00 | 28.57 | + |
| | PsC | 2.50 | 67.50 | 9.29 | 9.64 | 11.07 | |
| Drinking water deliver | PvC | 12.14 | 2.50 | 9.29 | 57.14 | 18.93 | + |
| | PsC | 9.64 | 50.36 | 14.64 | – | 25.36 | |
| Health care services | PvC | – | – | 4.64 | 64.29 | 31.07 | + |
| | PsC | 5.36 | 23.93 | 33.21 | 2.5 | 35.00 | |
| Education opportunity | PvC | – | – | 23.57 | 34.29 | 42.14 | + |
| | PsC | 23.93 | 63.57 | 12.5 | – | - | |
| Social relationship | PvC | 3.93 | 78.57 | 12.86 | – | 4.64 | - |
| | PsC | – | 7.14 | 73.57 | 2.5 | 16.79 | |
| Flood shelter | PvC | – | 2.86 | 7.14 | 37.86 | 52.14 | + |
| | PsC | 4.64 | 85.71 | 4.65 | – | 5.00 | |

PvC, previous condition; PsC, present condition; +, improved in the present location; -, decreased in the present location. Field survey.

## Perception of displaced individuals on the climatic variability

This section illustrates the people's perception on changing patterns of climate variables caused by climate change over the 12 years. Among the various climate variables, the study respondents shared their responses to the differences, where about half of the respondents believed that rainfall season slightly decreased, whereas 25.71% of the respondents argued that rainfall season increased to some extent. On the other side, approximately half of the respondents (45%) reported that rain intensity increased rapidly (Table 3).

Table 3 also reveals that 40.36 and 55.36% of displaced people believed that temperature increased rapidly and slightly during winter. In addition, summer temperature also comparatively increased where the majority of the respondents (64.29%) observed that summer temperature rapidly increased. For this reason, 63.93, 56.07, and 58.21% of respondents believed that the frequency of flood disasters, cyclones, and intensity of riverbank erosion had relatively increased, respectively. On the contrary, 48.93% of IDPs unfolded that heavy fog slightly increased due to climate change, and 27.50% of respondents believed heavy fog rapidly increased. Safe drinking water in the disaster-prone areas had scarcity due to climate change and its extreme hazards. In this regard, 27.14% and 40% of IDPs conveyed that the scarcity of safe drinking water rapidly and slightly increased, respectively, in the study area. Therefore, the disease outbreak in the study areas enhanced massively due to the changing climate. The majority of respondents (72.86%) believed that numerous diseases relatively increased in the study zones because of climate change and its associated disasters. The analyzed results and the observed data from NASA Power were almost parallel to the perception of internally displaced people (Figures 3, 4).

## Perceived impact of climatic hazards on livelihood

The study revealed that changing temperature, rainfall pattern, and disaster have directly affect the IDPs' livelihood over the last 12 years. Several livelihood capital problems, like human capital, social capital, financial capital, physical capital, and natural capital, were identified, and the impact intensity on livelihood capital is shown in Table 4, according to the IDPs' perception. In the case of human capital issues of IDPs due to climate change, people faced food uncertainty and malnutrition, health issues, unemployment, education disruption, and knowledge and skill issues. Therefore, the study found that almost 44.6%, 30.4%, and 25% of the respondents were confronted with large, medium, and slight food and malnutrition problems, respectively, in the previous location. Conversely, 13.9% of respondents did not face any difficulties; 31.8, 39.6, and 14.6% of respondents encountered slight, medium, and large impacts of food uncertainty and malnutrition, respectively, in the present location. The people were comparatively more vulnerable in the previous location than in the present place in the case of health issues, where 7.5% of the respondents did not face any health problems in their earlier setting and 23.9% of the respondents did not confront any health problems in the present site. Furthermore, 31.8% of the respondents found no unemployment in their previous location, whereas only 9.6% of respondents claimed no unemployment in the present location. The education sector is relatively much better for the IDPs in the current location than in the previous place. Concerning knowledge and skill, the IDPs did not face extensive problems in their previous and present locations.

On the contrary, IDPs were confronted with huge problems regarding social capital, like deteriorating social

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TABLE 3 People perception of climate change in the last 12 years.

| Climatic variables | Respondent's responses on changing patterns | | | | | |
|---|---|---|---|---|---|---|
| | Rapidly increased (%) | Slightly increased (%) | No change (%) | Slightly decreased (%) | Rapidly decreased (%) | Don't know (%) |
| Rainfall season | 16.43 | 25.71 | – | 46.07 | 7.14 | 4.64 |
| Rain intensity | 45.00 | 32.86 | 2.86 | 18.93 | – | – |
| Winter temperature | 40.36 | 55.36 | – | 2.14 | – | 2.14 |
| Summer temperature | 64.29 | 33.21 | – | – | 2.50 | – |
| Frequency of flood | 36.07 | 63.93 | – | – | – | – |
| Frequency of cyclone | 9.29 | 56.07 | 30.36 | – | – | 4.29 |
| Severity of Riverbank erosion | 41.79 | 58.21 | – | – | – | – |
| Heavy fog | 27.50 | 48.93 | 20.00 | – | – | 3.57 |
| Safe drinking water scarcity | 27.14 | 40.00 | 20.36 | 5.36 | – | 7.14 |
| Outbreak of diseases | 17.50 | 72.86 | 9.64 | – | – | – |

Field survey.

relationships, complicated organizational involvement, and problems accessing medical facilities. Thus, most IDPs conveyed that they did not face social relationship problems in their previous location. By contrast, only 10% of IDPs did not face social relationship problems in the existing site. Regarding the medical facilities, the IDPs believed that they are getting satisfactory facilities in the present location than in the ancestral place. On the other hand, the IDPs faced enormous complications triggered by climate change and its associated hazards concerning financial capital, such as access to formal and informal sources of loan decreased, a barrier to get occupation and income sources, disruption in savings, and crop loss. Table 4 also shows that loan facilities, occupation, and income were less impacted in the current location than in the prior place. In addition, crop loss is also reduced in the current location than in their ancestral place. In the case of physical capital, damaged and destroyed housing, worsened sanitation,

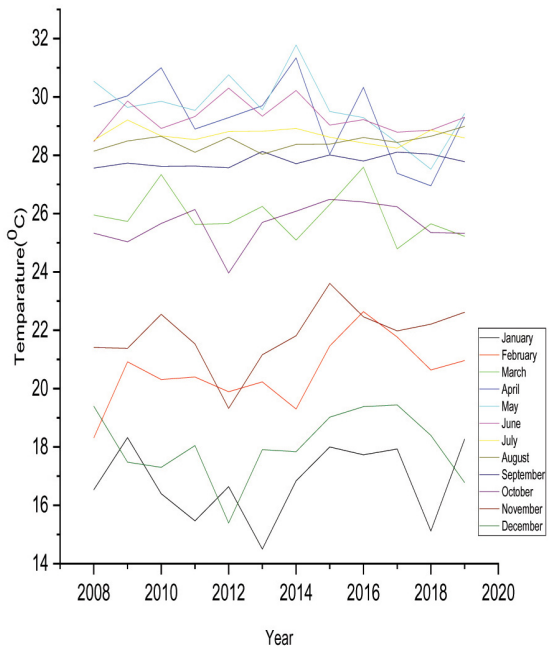


FIGURE 3
Monthly historical temperature pattern.

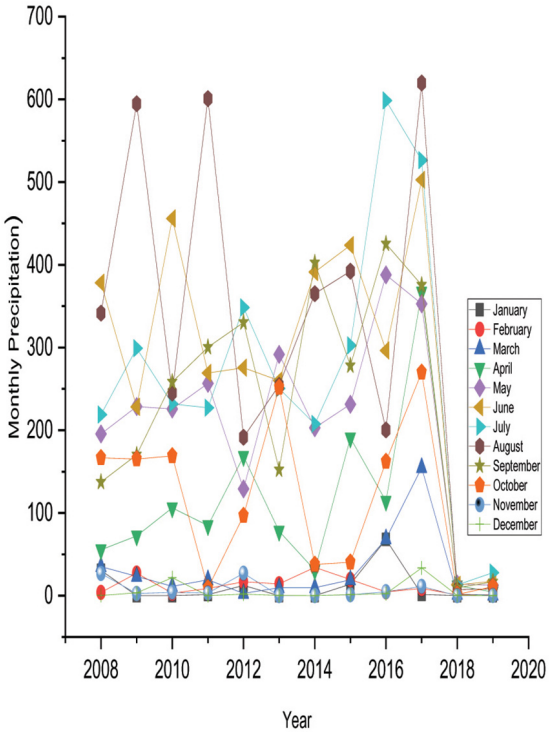


FIGURE 4
Monthly historical precipitation.

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TABLE 4 Perception of displaced people on the climate change impact on livelihood in the prior and present locations.

| Types of assets | Impacts | Description | Previous location (%) | | | | Present location (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | S | M | L | N | S | M | L |
| Human capital | Food uncertainty and malnutrition | Enlarged due to low production and income | – | 25.0 | 30.4 | 44.6 | 13.9 | 31.8 | 39.6 | 14.6 |
| | Disease/health condition | Due to household food uncertainty and inadequate access to health amenities, the vulnerable dwellers are susceptible to ailment and possess poor health. | 7.5 | 17.1 | 34.6 | 40.7 | 23.9 | 36.1 | 31.4 | 8.6 |
| | Unemployment | Reduced employment opportunities | 31.8 | 38.9 | 17.1 | 12.1 | 9.6 | 20.0 | 46.1 | 24.3 |
| | Education | Education facilities disrupts and damages | – | 27.5 | 40.0 | 32.5 | 23.9 | 48.9 | 23.6 | 3.6 |
| | Knowledge and skill | Disrupts of knowledge and skills of family members | 40.7 | 31.4 | 22.1 | 5.7 | 12.1 | 31.1 | 12.9 | 8.2 |
| Social capital | Social relationship | Deteriorating social relationship among the family members and beyond | 73.6 | 15.0 | 11.4 | – | 10.0 | 27.5 | 24.3 | 38.2 |
| | Organizational involvement | Complications of household members participation in the organizations | 12.1 | 52.5 | 24.3 | 11.1 | 81.4 | 18.6 | – | – |
| | Medical facilities | Problems to access to health services of the household's members | – | 11.4 | 35.0 | 30.0 | 22.1 | 38.6 | 23.6 | 15.7 |
| Financial capital | Loan facilities | Access to formal and informal sources of loan decreased | 15.7 | 20.0 | 36.1 | 28.2 | 35.0 | 40.0 | 20.0 | 5.0 |
| | Occupation and income | Barrier to get occupation and income sources | 23.9 | 18.6 | 35.0 | 22.5 | 18.2 | 34.6 | 36.8 | 10.4 |
| | Savings | The ability to save has decreased due to low income | 4.6 | 29.3 | 41.4 | 24.6 | 27.5 | 36.4 | 27.9 | 8.2 |
| | Crops | Crop's loss | – | 4.3 | 28.2 | 67.6 | 40.0 | 34.6 | 25.4 | – |
| Physical capital | Housing | Damage and destroy housing | 4.6 | 9.3 | 40.4 | 25.7 | 63.6 | 23.9 | 12.5 | – |
| | Sanitation facilitation | Worsened sanitation facilities | – | 12.1 | 42.5 | 45.4 | 36.8 | 32.5 | 30.7 | – |
| | Agricultural assets | Loss of household's agricultural assets | 27.5 | 31.8 | 37.5 | 3.2 | 75.7 | 24.3 | – | – |
| | Non-agricultural equipment's | Loss of household's non-agricultural assets | 4.3 | 35.0 | 39.6 | 21.1 | 78.2 | 21.8 | – | – |
| | Electricity (Solar/DB) | Deteriorated energy services | 20.4 | 31.8 | 40.0 | 7.9 | 75.7 | 16.8 | 7.5 | – |
| Natural capital | Land | Loss of land | 63.9 | 16.8 | 11.4 | 7.9 | 95.4 | 4.6 | – | – |
| | Drinking water | Complications regarding the availability of safe drinking water | 6.1 | 27.9 | 40.0 | 26.1 | 38.6 | 42.5 | 18.9 | – |
| | Livestock | Loss of livestock and paucity of fodder and poor animal health | 49.6 | 20.7 | 15.0 | 14.6 | 81.8 | 14.6 | 3.6 | – |
| | Fisheries | Shortage of fish in pond | 70.7 | 15.0 | 7.9 | 6.4 | 95.4 | 4.6 | – | – |
| | Social forestry | Loss of homestead trees | 63.9 | 20.4 | 9.6 | 6.1 | 92.5 | 7.5 | – | – |

Types of impacts: N, No.; S, slightly, M, medium; L, large. Field survey.

and loss of agricultural and non-agricultural assets were the key impacts on IDPs in their present and previous locations due to climate change and its associated hazards. In addition, Table 4 reveals that housing and sanitation damage and destruction are comparatively reduced in the current location than in the former place. On the contrary, 75.7 and 78.2% of the respondents

reported that no agricultural and non-agricultural assets were lost in the existing location. By contrast, only 27.5 and 4.3% of respondents claimed no agricultural and non-agricultural assets were lost in the former location. Natural capital was also impacted due to climate change and its associated hazards. The loss of land, disruption in collecting pure drinking water, livestock loss, and so on were the pivotal impact on the IDPs in their previous and present locations.

## Adaptation strategies by the respondents to livelihood resilience

As the climate change impacts on the displaced riverine char dwellers are enormous, the vulnerable inhabitants usually carry out various adaptation strategies to livelihood resilience. **Table 5** illustrates the adaptation strategies of IDPs to livelihood resilience.

**Table 5** reveals that 92.50 and 77.50% of the respondents reduced expenditure and reduced food consumption and storage of food, respectively. These are the most popular strategies for sustainable adaptation, and all categories of households followed this to counter climate change and its associated hazards. In addition, a majority of IDPs engaged in several occupations to adapt to the overwhelming condition, such as begging (24.29%), housemaid servant (27.50%), work as day labor (45.36%), street hawker (13.23%), and off-farm worker (63.21%). Mostly, these occupations are prevalent in low and medium households, and the FGDs revealed that IDPs try to find this work every day. On the contrary, most households are rearing goat (70.36%) and chicken and duck (96.79) after the displacement from their ancestral place. FGDs unfolded that rearing goat, chicken, and duck is a rapid source of financial solvency, and it is also a major source of rich food.

All the respondents usually visit government hospitals and quack doctors to treat illness as they did not have such healthcare facilities in their earlier location. Moreover, 96.07% of respondents use a mosquito net to preclude vector-borne ailments since they are not living in hygienic places, and their houses are fragile. In addition, 40% and 60% of the respondents have made their housing to live in Khas land (Khas land is a state-owned fallow land where nobody has property rights.), rent, and relative homestead. On the other hand, 66.07% of IDPs are collecting drinking water from road side public taps and tube wells located in their street/slum, and it is very popular between the low- and middle-income households. Moreover, FGDs revealed that children of IDPs are comparatively getting the opportunity for education in the present location than in the previous location, and almost 63.57% of the children attend the government primary school.

Furthermore, approximately all the IDPs revealed that they took a loan from NGOs, money lenders, relatives, and neighbors. This strategy was followed by almost all households after the displacement for the financial affluence to cope with the adverse situation. Also, some of the households (13.57%) received housing elements amenities from the GOs and NGOs. Mainly, most IDPs do not have cultivable land, so 34.43% of the respondents claimed that they took Borga (sharecropping) to cultivate different crops. Therefore, it can be said that the IDPs took various adaptation measures to cope with climate change and its associated numerous complications after being displaced from the ancestral place.

## Factors hindering the livelihood adaptation strategies

Since the IDPs formed several adaptation strategies to prevent the overwhelming situation, they also identified various barriers against the adaptation strategies. **Figure 5** delineates the components of adaptation obstacles to the livelihood resilience of the displaced people.

**Figure 5** shows that most respondents (59.64%) had not owned a land. This is why they faced enormous complications to adapt to the adverse situation after the displacement. A respondent talked concerning this as follows:

> *"I am a poor man. I was living in the riverine char and working as day labor. I did not have cultivate land except my homestead. We were happy with my family but one day our happiness had ended because of riverbank erosion. We lost our homestead as well as household assets. Then, we had looked for a place to live but did not find a place near our home. After that, we came here to live but we are facing some problems including homestead land, which has disrupted our lives massively"(Interviewee# 25).*

Overall, 95.71 and 86.79% of the respondents believed that fragile housing and lack of saving money, respectively, were the pivotal barriers to adaptation in the face of crisis after the displacement. The FGDs revealed that the displaced people were not financially strong enough to manage life and livelihood issues. For this reason, most of the IDPs could not make sustainable housing due to financial problems. However, approximately 27.5% and 16.78% of the respondents reported that women's cultural diversity and social insecurity were also significant barriers to adapting to the displacement's adverse circumstances. On the contrary, 60.36% of the IDPs had limited opportunity to borrow money, which was also one of the obstacles. Regarding this matter, a respondent stated his/her opinion as follows:

> *"We are a homeless individual living in the demesne (Khas land). In fact, we don't have liquid money to cope with the complications. Still, at least we were able to manage some*

*money from different sources like Mahajan, local NGOs, relatives and so on at our earlier location. But here, we have not received financial help as a loan from anywhere. We communicated some of the sources, but we could not meet up their requirement to get money. Although some of the individuals (Mahajan) agreed to provide us with some money, the interest rate was very high, as we are poor how we can repay the money at high interest. For this reason, we are confronting endure a lot of barriers to tackle the dynamic problems of life and livelihood" (Interviewee# 44).*

## Discussion

There is much evidence showing that climate change has a severe impact on displaced people in Bangladesh, along with the increasing severity and occurrence of catastrophes (IPCC, 2014; Alam et al., 2017). Field observation in Saghata and Fulchari also portrayed that owing to scarcity of social kinship and possessions, there is limited earning opportunity, which makes displaced people most susceptible. Although some of them can manage their earnings, their incomes are insufficient to support a family, which impacts their quality of life and health issues. Livelihood challenges are faced by the char dwellers due to a lack of education, less work opportunity, and low earnings, which is consistent with the outcomes of a study directed by Ahmed and Atiqul Haq (2019) and Haque et al. (2020).

The study exposed that six drivers induced massive displacement in the study area. The drivers and factors of displacement are considerably influenced promptly by climate change and its associated hazards. This study revealed that the main reasons for escalating displacement in Saghata and Fulchari upazilas are frequent flood disasters, riverbank erosion, and crop loss. Riverine char regions of Bangladesh are vulnerable to various calamities, such as flood disasters, riverbank erosion, and drought. For this reason, people are confronted with huge losses regarding lives and livelihood every year. In this case, Zaman (1989) and Alam et al. (2020) also identified that the internal migration is rising in riverine char regions of Bangladesh owing to implications of these sorts of catastrophes. Conversely, Barua et al. (2017) and Shi et al. (2019) examined that financial difficulties are strongly linked to internal migration in developing nations. According to this study, internal migration was found to be increasing due to the loss of livelihood and harm to agriculture. Also, in this study, social services and livelihood opportunities available in the former and current places were account for after their displacement. Considering societal amenities, Islam and Hasan (2016) and Kabir et al. (2018) explained that defenseless people relocate to developed areas where communication system, drinking water accessibility, and flood living quarters were available. However, the displaced people of char areas need time to adjust to society and form positive relationships. Conflict arises among IDPs in some circumstances due to a lack of shared resources, and nearby settled people refuse to grant access to their lands. Apart from all of these considerations, migrants usually evaluate their family situation and road communication conditions while determining their migration destination and period (Martin et al., 2014).

According to the findings, the IDPs detected changes in growing or reducing trends for various climatic factors at their current locale compared to their former places. Likewise, Hossain et al. (2021) indicated that temperature, precipitation, and calamities are shifting an intense stage. Nishat and Mukherjee (2013) mentioned that in current years, Bangladesh has seen an increasing trend of escalating temperatures and various sorts of calamities and a shifting form of yearly precipitation. Rahman and Lateh (2017) noticed that the average temperature of Bangladesh is increasing at a rate of 0.20 °C per decade, indicating an upward trend in temperature, which is consistent with displaced people's perceptions of the rising temperatures. Likewise, to highlight the possibility of natural catastrophes in Bangladesh, District Disaster Management Committee (2014) predicted that floods and cyclones would increase because of the increasing tendency of sea surface temperature and rainfall.

In the northern zone, particularly in char areas of Bangladesh, approximately all households confronted life and livelihood complications caused by climate change and its associated hazards. Since they are directly and indirectly dependent on agriculture, this sector is impacted enormously triggered by extreme calamities regularly. Islam (2018) and Hossain et al. (2020a) stated that flood disasters and riverbank erosion are the pivotal reasons for encountering life and livelihood difficulties in the char areas. The present study found that the IDPs addressed several short- or long-term challenges concerning life and livelihood. These rising livelihood complications are due to changing climate such as increased rainfall season and rain intensity, frequent flood disaster and riverbank erosion, and crop loss. Alam et al. (2020) delineated that several impacts like food shortage, unemployment, and disruption of education due to climate change are found in the char areas. The IDPs have also reported the same problems they faced in the present and previous locations. In addition, they identified that food security and education facilities at the present locations were higher than those in their previous regions. On the contrary, many respondents unfolded that they suffered from several health issues, such as vector-borne and waterborne diseases, which is coherent with other studies (Pyle et al., 2009; Hossain et al., 2021). Furthermore, the IDPs believed that they encountered numerous diseases in both locations, which impedes their sustainable way of life. Furthermore, the displaced people addressed that after being displaced to a new place, there has been some deterioration in social relations between family members as well as members of the new society, which is consistent with the findings of the research directed by

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TABLE 5 Adaptation strategies of IDPs in the context of livelihood resilience.

| Adaptive measure | Responses (%) | Household income category (%) | | | Comments |
|---|---|---|---|---|---|
| | | Low | Medium | High | |
| Reduce expenditure | 92.50 | xxx | xxx | xxx | PA/ILA |
| Reduce food consumption and storage of food | 77.50 | xxx | xxx | xxx | PA/ILA |
| Begging | 24.29 | xxx | xx | – | ILA |
| Housemaid servant | 27.50 | xxx | xxx | – | ILA |
| Work as day labor (farm related) | 45.36 | xxx | xxx | xx | ILA/PA |
| Goat rearing | 70.36 | xx | xxx | xxx | ILA/PA |
| Chickens and duck rearing | 96.79 | xxx | xxx | xxx | ILA/PA |
| Street hawker (tea, vegetables seller, etc.) | 13.23 | xxx | xxx | x | ILA |
| Off-farm work (Van, rickshaw, *nachimon*, *korimon* and tempo, driver | 63.21 | xxx | xxx | xx | ILA |
| Take treatment (Govt. hospital, Quack doctor) | 100.00 | xxx | xxx | xxx | ILA/PA |
| Use mosquito net to prevent vector-borne diseases | 96.07 | xxx | xxx | xxx | ILA/PA |
| Taking Borga | 36.43 | xx | xx | xxx | PA/ILA |
| Housing elements amenities (GOs and NGOs) | 13.57 | xxx | xxx | xxx | PA |
| Taking loan (NGOs, moneylender, relatives and neighbor) | 98.93 | xxx | xxx | xxx | PA/ILA |
| Schooling of children (Govt. primary school) | 63.57 | xxx | xxx | xxx | PA/ILA |
| Use community sanitation | 27.50 | xxx | xx | – | PA/ILA |
| Collect drinking water (Road side public tap, Tub well located in street/slums) | 66.07 | xxx | xxx | x | ILA |
| Take shelter (Khas land) | 40.00 | xxx | xxx | xx | ILA |
| Housing (rent and/or relatives homestead) | 60.00 | xxx | xxx | xxx | ILA |

xxx, high popular; xx, medium popular; x, low popular; ILA, individual-level adaptation based on experience and knowledge; PA, planned adaptation (supported by GOs and NGOs). Source: field survey; multiple responses have been considered.

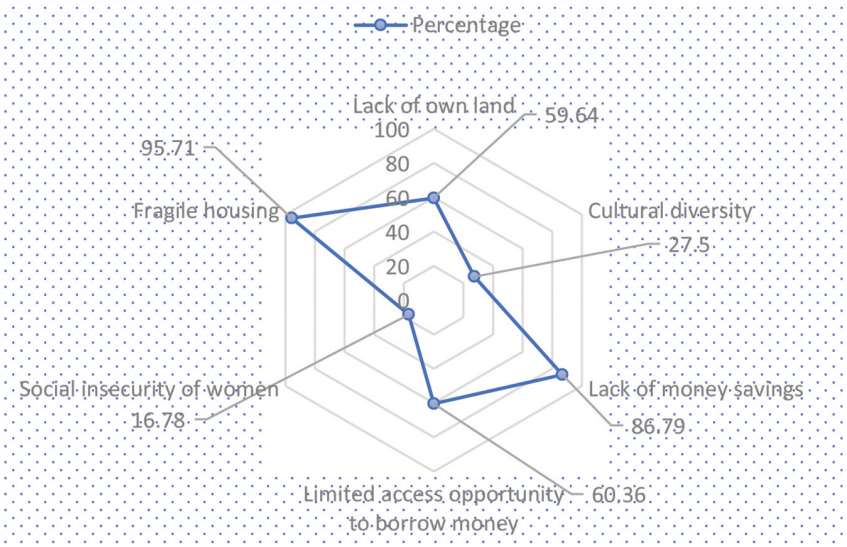


FIGURE 5
Radar chart on components of adaptation obstacles to livelihood resilience.

Hynie (2018) and Nikuze et al. (2019). In addition, Hossain et al. (2020a) discussed that the IDPs seemed to be helpless and hopeless after being displaced. A lack of intact social relationships made them more fragile and vulnerable. In addition, the study respondents reported that they faced several types of social, financial, physical, and natural capital problems due to the changing climate and its associated hazards both at the new and previous locations, which is similar to research conducted by other researchers (Alam et al., 2017; Islam and Shamsuddoha, 2017).

Adaptations at different levels using both physical and environmental strategies are required to maintain a viable way of life in the face of climate change consequences (Munroe et al., 2012). The IDPs have adopted several adaptation strategies in terms of their household income capacities to cope with the adverse situations. Similarly, Barua et al. (2017) and Jha et al. (2018) disclosed that different adaptation measures followed by the displaced people formulated based on the individuals' level or planned adaptation supported by GOs and NGOs could be worthwhile to ensure the sustainable livelihood against the climate change penalties. In addition, Barua et al. (2017) stated that these adaptation practices make an effort to diminish the displacement risk for the households in future caused by climate change and its amalgamated hazards. Also suggested taking rearing livestock, petty business, visiting doctors, off-farm working, employing traditional practices, and consulting relatives, friends, and neighbors to cope with the shifting pictures of climate change effects on life and livelihood. Following from the significance of adaptation in securing sustainable livelihood in the face of climate change, Brouwer et al. (2007) and Hossain et al. (2020a) emphasized the inevitability of executing appropriate adaptation mechanisms through long-term measures in less developed nations like Bangladesh. Women, youths, and the elderly are the groups that demand special concentration to properly carry out the acclimatization programs, where school-based learning would emphasize climate change and livelihood adjustment (Kabir M. I. et al., 2016; Luetz, 2018).

On the other hand, identifying the obstacles to adaptation in the face of climate change is essential for designing effective livelihood coping mechanisms (Alemayehu and Bewket, 2017). The fragile financial status among the various shapes of obstacles is the most underlined factor, which diminishes the adjustment competencies (Moser and Ekstrom, 2010; Hossain et al., 2020a). Likewise, the monetary crisis is one of the pivotal barriers for the displaced people in Saghata and Fulchari regions. A majority of respondents are engaging as a rickshaw puller, day labor, beggar, bricklayer, and street hawker, and so on. In addition, respondents also reported some of the barriers, such as lack of land and fragile housing, to cope with livelihood issues, as found in the research conducted by Nikuze et al. (2019).

This study findings have significant policy implications for countries like Bangladesh. The outcomes of this study have immediate implications for countrywide policy priorities such as poverty reduction, ultra-poor improvement, island livelihood projects, and distinct assistance for socially excluded people. Acute poverty in disaster-prone regions like char is one of the key points in the poverty alleviation strategy of the Bangladesh government (International Monetary Fund, 2005). The government recognizes that the displaced people in disaster-prone areas are rigorously underprivileged based on land rights, paucity of right to use to formal finance, and other fundamental facilities (Paul and Islam, 2015). The Sustainable Development Goals (SDG) in Bangladesh have an explicit purpose of lessening extreme poverty in the countryside areas. Therefore, climate change and disasters, including socioeconomic vulnerabilities and other risks faced by island dwellers and/or displaced people, must be mapped to improve their ability to recover and adapt to threats. In addition, potential disaster resilience guides should be formulated to categorize an institute systems, measures, and functioning circumstances in the aftermath of calamities. The study outcomes noticeably display that owing to their little human assets, economic vulnerabilities, and so on, the respondents had no choice but to relocate to the mainland or surrounding towns.

## Conclusion

Each year, a huge number of individuals internally displace in Bangladesh, where riverine char regions are highly prone to extreme flooding, riverbank erosion, etc. Among the overall population of the disaster-prone areas in Bangladesh, char dwellers are one of the most vulnerable people to natural disasters, including changes in other climatic factors, which induce them massively to be displaced. For this reason, the displaced char inhabitants confront enormous complications with regard to lives and livelihood without discriminating, which make them even more vulnerable. This study aimed to examine the impact on the lives and livelihoods of IDPs caused by climate change, including local adaptation mechanisms. It is revealed that the char dwellers are displaced to a new place from their ancestral locations due to climate-induced disasters like floods, riverbank erosion, and their consequences. The relocated people reported facing huge impediments such as housing and sanitation problems, food uncertainty, health problems, and various social issues after being displaced in a new place. Even though they formulated copious adaptation strategies like reducing expenditure and food consumption, begging, livestock rearing, and taking shelter in demesne land to eliminate their livelihood issues and to sustain lives. The livelihood resilience strategies of displaced people were interrupted owing to numerous obstacles, such as paucity of money, lack of own land, fragile housing, and social insecurity. Furthermore, the adaptation

strategies of displaced people vary based on a household's income capacity since most families' financial condition is not good enough.

However, GOs and NGOs, including all people working for vulnerable people, should use a significant development strategy to ensure a viable adaptation approach is established and various forms of obstructions for the IDPs are evaded. On the other hand, future studies could be conducted with numerous displaced people in many disaster-prone zones since this study was carried out in only two upazilas of Gaibandha district. Also, a longitudinal study could also be carried out to understand the thorough scenarios of the climate-induced displacement of people.

## Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

Studies involving human participants were reviewed and approved by the Behavioral and Social Sciences Ethical Review Committee (BSSERC) of Hohai University, Nanjing, China. Written informed consent from the patients/participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

BH initiated the study. BH, MNIS, GS, and MSS collected the data and wrote the manuscript. BH, GS, and CA processed the data and performed statistical analysis. BH, MNIS, CA, ZS, and QY revised the manuscript. All authors read and approved the final manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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# Entrepreneurial effect of rural return migrants: Evidence from China

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Entrepreneurship is an important means of economic development. Rural migrant workers returning home to start their own businesses can promote employment, alleviate poverty, and achieve rural development structural transformation of rural development. The entrepreneurial effect of rural return migrants is important for rural economic development. Using the data of the China Labor Force Dynamics Survey (CLDS thereafter) 2018 and China Household Finance Survey (CHFS thereafter) 2019, we analyze the entrepreneurial effects of return migrants upon their return to their hometowns. We construct a career choice model and build a mathematical model based on it to formulate the hypothesis. Then, we use the Probit regression model to test the hypothesis empirically. Results find that the rural return migrants can promote entrepreneurship among residents. Land circulation, human capital, and physical capital are stimulating factors in promoting the rural entrepreneurial activities of return migrants. We recommend that the government actively guide the rural return migrants to start businesses and provide security for entrepreneurial activities by upgrading various entrepreneurial elements.

KEYWORDS

**rural return migrants, entrepreneurship, land circulation, physical capital, human capital**

## 1. Introduction

Entrepreneurial activities are conducive to promoting innovation, enhancing market competition, and creating jobs. As China's economy shifts from high growth to high-quality development, creating an entrepreneurial and innovative ecology has become an urgent requirement for economic development (He et al., 2019; Li D. et al., 2022). With the promotion of national entrepreneurship policies and the encouragement of local entrepreneurship education, entrepreneurial activities are becoming increasingly active and the number of entrepreneurial enterprises is growing rapidly. In entrepreneurial activities, the participation of farmers has gradually increased, becoming an important part of the current entrepreneurial community (Miao et al., 2021). Entrepreneurship of farmers helps to drive the employment of surplus rural labor and alleviate the

current employment difficulties. It also increases farmers' income and promotes rural revitalization and prosperity (Naminse et al., 2018).

Since the opening-up reform of China in 1978, the government has actively promoted industrialization and urbanization, encouraging surplus labor from rural areas to move to urban areas for employment to coordinate urban–rural integration development (Liang and Morooka, 2004; Liu et al., 2015). Meanwhile, there are always many migrants returning to the countryside due to the "pull" or "push," making career choices between starting a business, working, or farming (Ma, 2002; Jia and Liu, 2014). Driven by the entrepreneurship policy, the government actively encourages migrant workers to return to their hometowns and engage in entrepreneurship, to achieve sustainable development in rural areas. Compared to farmers staying in the local area, returning entrepreneurs have more advantages in economic, human, and social capital and play a leading role in promoting transformation, upgrading the rural industries, and promoting employment in rural areas (Naminse et al., 2018). Therefore, the rural return migrants can realize the entrepreneurial effect is important for the government to formulate scientific entrepreneurship and rural development policies.

Rural return migrants also bring with them the movement of various production factors such as knowledge, skills, and capital. These factor flows to optimize the conditions for residents to start their own businesses and influence their career choices. In the process of going out to work, people are able to learn knowledge and exercise skills. Rural return migrants bring knowledge and skills back to their hometowns, driving the flow of human capital. In addition, the main purpose of working outside the home is to obtain higher returns and accumulate wealth, which provides the basis for rural return migrants to start their own businesses (Yang and Wen, 2020). Meanwhile, the choice of rural return migrants to work outside, especially on a long-term basis, often means people would give up their land holdings, which will further lead to the transfer of land (Deininger and Jin, 2009). Rural return migrants who return to the countryside are more likely to start their own businesses because of the relatively small amount of land available (Barth and Zalkat, 2021).

Existing literature on entrepreneurship focuses on the factors and consequences. The factors that influence entrepreneurship focus on individual, social, and policy aspects. Individual factors include education, risk appetite, occupation experience, and family background (Halvarsson et al., 2018; Duleep et al., 2022; Giacomin et al., 2022). Social factors refer to migration and mobility (Lee and Eesley, 2018; Duleep et al., 2022), the internet economy and digital finance (Cumming and Johan, 2010; Liu et al., 2022), and the business environment (Wu and Lin, 2021). Entrepreneurial support policies such as tax relief (Darnihamedani et al., 2018; Audretsch et al., 2022), government decentralization (Rangus and Slavec, 2017; Zeng and Wen, 2021), and approval process simplification (Li et al., 2021; Shi and Frenkiel, 2021). Entrepreneurial support policies are also influencing entrepreneurial choices. However, none of the above studies has examined the entrepreneurial effects of rural return migrants.

Rare literature refers to the entrepreneurial effects of the rural return migrants. Although some scholars have started to focus on this area, they have focused more on migrants who leave the countryside to work and tried to explain how the rural return migrants contribute to resident entrepreneurship (Ma, 2002; Démurger and Xu, 2011; Jia and Liu, 2014; Jia et al., 2017; Oostendorp, 2017; Zhou et al., 2017; Wang et al., 2018; Li Y. et al., 2022; Wu et al., 2022). But these do not answer the question of whether and how the rural return migrants impact rural entrepreneurship.

From the above analysis, existing literature mainly focuses on the economic effects of rural return migrants, but less discusses the entrepreneurial effects. We attempt to answer the question "whether rural return migrants affect entrepreneurship" from both theoretical model and empirical analysis. We first construct a model of occupational choice to analyze the different returns to residents engaging in entrepreneurship, working, and farming, as well as the occupational choices made under changing resource endowments and constraints. Based on the mathematical model, we propose a hypothesis that the rural return migrants affect entrepreneurship through land circulation human capital and physical capital. Then, we use China Labor Force Dynamics Survey (CLDS) (2018) and China Household Finance Survey (CHFS) (2019) to empirically test the entrepreneurial effects of rural return migrants. We find rural return migrants have a positive effect on entrepreneurship, and this positive effect holds when controlling for the remaining variables. The findings still hold when considering endogeneity. We further find that the entrepreneurial effect of the rural return migrants is mainly formed through land circulation, human capital, and physical capital.

This study examines the return of rural labor to their hometowns in the context of current economic development, and the results are important for world economic development. Whether or not rural migrants choose to return to their hometowns is ostensibly guided by policy and economic development but is actually the result of human psychological and behavioral choices. The contributions of this paper mainly include: First, existing studies have mainly focused on the migration of migrant workers from rural to urban areas (Zhang and Wang, 2010; Lan, 2014; Chen and Liu, 2016; Roberts, 2018; Ge et al., 2020; Qiao et al., 2022), with few studies on the economic consequences of rural return migrants and studies on their entrepreneurial effect. We construct a theoretical framework for the analysis of the impact of rural return migrants on entrepreneurship to

find the practical basis and enrich the existing rural labor mobility, economic growth, and psychological theories from a new perspective. Second, we focus on the indirect mechanism of rural return migrants affecting residents' entrepreneurship from human capital, physical capital, and land circulation. This series of factors reflects the impact of the economic development environment on psychological and behavioral choices, which complements the research in the field of psychology and economics. It further expands the mechanism by which the rural return migrants influence entrepreneurship, and thus makes the dynamic mechanism research clearer. In addition, we focus on the trajectory of rural return migrants and their impact on entrepreneurial behavior. Our findings contribute to allocating rural labor resources scientifically and rationally and improving the efficiency of economic activities and promoting the quality transformation of the current economy. This is particularly relevant to the declining birth rates and the increasing aging of the population worldwide.

The remainder of the paper proceeds as follows. Section 2 "Theoretical models and hypotheses" covers the theoretical models and hypotheses. Section 3 "Methodology" presents the methodology. Section 4 "Results" outlines the results and discussion. Section 5 "Mechanisms" adopts a mechanisms analysis. Finally, section 6 "Conclusion and implications" summarizes the main conclusions and implications.

# 2. Theoretical models and hypotheses

## 2.1 Assumptions

To analyze the occupational choice behavior of the population through a mathematical model, we make the following theoretical assumptions:

i. People are rational and make career choices based on maximizing two-phase utility.

ii. Utility satisfies the general utility function $u(\cdot)$, $u'(\cdot) > 0$, and $u''(\cdot) < 0$, when the dependent variable is consumer funds.

iii. Individuals have different endowments and preferences. Specifically, (a) physical capital ($\omega_i$), where individuals have different initial capital due to objective constraints, and income and spending power. (b) discount rate ($\beta_i$), where the discount rate varies due to different risk appetites and expected returns. (c) loan limits ($\bar{b}_i$), where credit conditions, social connections, and other aspects possessed by individuals result in differences in the ability to access funds and different maximum loan amounts.

iv. Workers will receive wages, the farmer will receive income from agricultural product sales, and entrepreneurs will receive the return from entrepreneurship if they succeed or obtain residual if they fail. $w_i$ denotes wage, determined by human capital. $f_i$ measures output per unit of land. $p$ is the probability of entrepreneurial success. The entrepreneurs receive the return of $y_s$ for a successful venture and otherwise $y_f$ .

v. The model only discusses the current and future periods. As income from the second and infinite subsequent periods can be discounted to the second period, this is reflected mathematically as a change in the discount rate in the second period. Also, the model does not rely on the specific setting of the discount rate.

vi. The impact of job promotion and investment volatility is not considered. As only two periods of returns are discussed, the case of appreciation and investment volatility can be excluded and as they are not the focus of this paper, ignoring the case of appreciation and investment volatility has the effect of simplifying the model.

vi. The model does not include the impact of job promotions and investment fluctuations. The model only discusses two-period returns, and thus excludes job promotions and investment fluctuations.

The variables involved in the model and their definition are shown in **Supplementary Appendix 1**.

## 2.2 Occupational option models

We consider a simple two-period career choice model: individuals can autonomously allocate resources in the first period, while the initial resource allocation will determine the total utility in the future. Initial resource allocation aims to maximize the total utility. The total utility includes two components: (i) current consumption utility, and (ii) discounted future potential utility. Specifically, residents can determine their loan ($b_i$) and investment amount ($m_i$) in the first period, which will further determine their consumption in both periods ($x_i$, $y_i$). Total utility is a function of consumption. Therefore, we can determine the optimal loan ($b_i^*$) and investment ($m_i^*$) to maximize total utility ($U_i = V_i$). By comparing the total utility from different career choices, it will select the career with the highest total utility. Residents make decisions based on the utility of entrepreneurship.

### 2.2.1 Entrepreneurial returns

First, we discuss the returns to resident entrepreneurship. Entrepreneurs aim to maximize two-period utility, so we use Eq. (1) to measure the total utility of entrepreneurship and satisfy the constraints.

$$\begin{aligned}&\max U_{ei}\left(x_i, y_{s,i}, y_{f,i}\right)\\&= u\left(x_{e,i}\right) + \beta\left[pu\left(y_{s,i}\right) + \left(1-p\right)u\left(y_{f,i}\right)\right] = u_{e,1}\left(\omega_i, b_i, m_i\right)\\&+\beta\left[pu_{e,2}\left(R_i, r, b_i, m_i\right) + \left(1-p\right)u_{e,3}\left(\emptyset, r, b_i\right)\right]\end{aligned} \quad (1)$$

$$
\begin{aligned}
s.t.\ \ x_{e,i} &= \omega_i + b_{e,i} - m_i \\
y_{s,i} &= R_i m_i - r b_{e,i} \\
y_{f,i} &= \emptyset - b_{e,i} \\
b_{e,i} &\le \bar{b}_i \\
0 &\le x_{e,i},\ y_{s,i}, y_{f,i}
\end{aligned}
$$

In Eq. (1), we believe the total individual utility includes two components: (i) current utility, and (ii) expected entrepreneurship utility. β is the discount rate, $\beta \in (0.1)$. $p$ is the probability of success of the venture, $p \in (0.1)$. The success of entrepreneurship is influenced by the external environment. When the resident succeeds in starting a business, the funds used for consumption are $y_{s,i}$, otherwise $y_{f,i}$. Note that since $u''(\cdot)< 0$, the expected utility of consumption here is not equal to the utility of expected consumption.

For the constraints, the first three equations are the consumption. Consumption is the original capital accumulation $\omega_i$, plus the loan $b_{e,i}$, and minus the entrepreneurial capital $m_i$, as entrepreneurs have invested and taken out a loan in the first period. In the second period, the return $y_{s,i}$ is the entrepreneurial return minus the repayment amount in case of a successful start-up, or no start-up return under a failed start-up. $R_i$ is the investment return and measures entrepreneurial talents. The more talented the entrepreneur, the higher the return on investment. Generally, the benefits of entrepreneurship outweigh the costs ($R_i$>1). We also assume only residuals Ø remain after investment failure. The loan has to be repaid regardless of the outcome of the investment. $r$ is the borrowing rate, and therefore, the consumption amount less $rb_i$ in the second period. Therefore, if the investment is successful, consumption in the second period is the investment return minus the loan repayment. Conversely, the investment residual minus the loan amounts.

The fourth constraint indicates that an individual cannot borrow more than the maximum loan amount he or she can obtain through various sources $\bar{b}_i$. The fifth constraint means that people invest rationally and will ensure their most basic survival needs whether they succeed or not. $x_{e,i}$, $y_{s,i}$, and $y_{f,i}$ are all positive.

Therefore, we can determine the indirect utility function $V_{e,i}$ for the entrepreneur's optimal loan $(b^*_{e,i})$ and investment $(m^*_i)$ based on individual conditions. Rational individuals will self-select the optimal amount. The choice of loan and investment is not the focus of this study, thus, the specific values and expressions are not derived.

Optimal loan amount. We make Eq. (2) equal to zero to obtain the individual optimal amount of maximum utility $b^*_{e,i}$. Since there is a range restriction, if $b^*_{e,i} > \bar{b}_i$, then let $b^*_{e,i} = \bar{b}_i$. $U'_{ei}\left(b^*_{e,i}\right) > 0$ when the above case is satisfied, but $U_{ei}$ is also the utility at the optimal loan amount:

$$
\begin{aligned}
U'_{ei}\left(b^*_{e,i}\right) = \frac{\partial U_{ei}}{\partial b_{e,i}} &= \frac{\partial u(x_{e,i})}{\partial b_{e,i}} + p\beta\frac{\partial u(y_{s,i})}{\partial b_{e,i}} \\
&+(1-p)\beta\frac{\partial u(y_{f,i})}{\partial b_{e,i}} \ge 0
\end{aligned} \tag{2}
$$

Optimal entrepreneurial amount. Similar to the above, let $U'\left(m^*_i\right)$=0, to obtain the optimal investment amount $m^*_i$. Although $m_i \in [0, \omega_i + b_i]$, since $u''(\cdot)<0$, $m^*_i$ must fall within the interval. Thus, $U'_{ei}\left(m^*_i\right)$=0 must hold, satisfying Eq. (3):

$$
U'_{ei}\left(m^*_i\right) = \frac{\partial U_{ei}}{\partial m_i} = \frac{\partial u(x_{e,i})}{\partial m_i} + p\beta\frac{\partial u(y_{s,i})}{\partial m_i} = 0 \tag{3}
$$

The indirect utility function $(V_{ei})$ of the individual corresponding to the optimal personal loan$\left(b^*_{e,i}\right)$ and investment $\left(m^*_i\right)$ derived from Eq. (2) and Eq. (3), is shown in Eq. (4):

$$
\begin{aligned}
&V_{ei}\left(\omega_i, R_i, r, \emptyset\right) \\
&= u_{e,1}\left(\omega_i, b^*_{e,i}, m^*_i\right) + \beta\left[p u_{e,2}\left(R_i, r, b^*_{e,i}, m^*_i\right)\right. \\
&\left.+\left(1-p\right)u_{e,3}\left(\emptyset, r, b^*_{e,i}\right)\right]
\end{aligned} \tag{4}
$$

After determining loans and investments, the maximum utility $U_{ei}$ can be represented by the $V_{ei}$ in Eq. (4), determined only by the individual $(\omega_i, R_i)$ and environmental characteristics$(r,\ \emptyset)$.

### 2.2.2 Work returns

Similar to entrepreneurial returns, work returns are also affected by the discounting of the first and the second period utility, and the consumer still aims to maximize both periods' utility as shown in Eq. (5). The difference is that the effect of the second period utility as a result of wage. We assume wage $w_i$to be stable, thus, the utility from the wage is also stable:

$$
\begin{aligned}
\max U_{wi}\left(x_i, y_i\right) &= u\left(x_{w,i}\right) + \beta u\left(y_{w,i}\right) \\
&= u_{w,1}\left(\omega_i, b_{w,i}\right) + \beta u_{w,2}\left(w_i, b_{w,i}, r\right)
\end{aligned} \tag{5}
$$

$$
\begin{aligned}
s.t.\ x_{w,i} &= \omega_i + b_{w,i} \\
y_{w,i} &= w_i - r b_{w,i} \\
b_{w,i} &\le \bar{b}_i \\
0 &\le x_{w,i},\ y_{w,i}, y_{w,i}
\end{aligned}
$$

Since there is no investment in the utility of the first period, $x_{w,i} = \omega_i + b_{w,i}$. However, it could allocate capital across periods using loans. When $b_{w,i} > 0$, the individual uses a loan for consumption. Conversely, when $b_{w,i} < 0$, the individual deposits part of the current capital for consumption in the next period and receive interest $r$. Thus, two-period income

includes the impact from borrowings and loan repayments. Wage remains unchanged, so consumption in the second period can be expressed as $w_i - rb_{w,i}$. The remaining restrictions are the same as in the case of entrepreneurial returns.

First, we determine the optimal loan. The utility of the worker is also affected by the loan ($b_{w,i}$). Individuals can allocate funds across time with different loan amounts. We can obtain the optimal loan $b^*_{w,i}$ when the first-order partial derivative is 0, and $b^*_{w,i}$ satisfies $U'\left(b^*_{w,i}\right) \geq 0$ [refer to Eq. (6)]. Specifically, when $b^*_{w,i} \in [0, \bar{b}_i]$, $U'\left(b^*_{w,i}\right) = 0$. Otherwise, $U'\left(b^*_{w,i}\right) > 0$ and $b^*_{w,i}$ are still the optimal loan:

$$U'_{wi}\left(x_i, y_i\right) = \frac{\partial U_{wi}}{\partial b_{w,i}} = \frac{\partial u(x_{w,i})}{\partial b_{w,i}} + \beta \frac{\partial u(y_{w,i})}{\partial b_{w,i}} \geq 0 \quad (6)$$

Then, we believe that since the worker does not invest, his indirect utility function follows Eq. (7). The maximum utility of the worker is limited by the $\omega_i$, $w_i$, and $r$:

$$V_{wi}\left(\omega_i, w_i, r\right) = u_{w,1}\left(\omega_i, b^*_{w,i}\right) + \beta u_{w,2}\left(w_i, b^*_{w,i}, r\right) \quad (7)$$

### 2.2.3 Farming returns

In addition to entrepreneurship and work, rural return migrants can also choose to engage in agricultural activities. Similar to entrepreneurship and work returns, we can obtain farming returns of rural residents and the corresponding two-period maximum utility using Eq. (8). Variables are the same as in the previous section. The difference is that farming returns are determined by the area of arable land owned by the rural resident and the agricultural production level. $A_i$ is the arable land the rural resident owns, and $f_i$ is the agricultural production level of the individual, which measures output per unit of land:

$$\begin{aligned} \max U_{ai}\left(x_i, y_i\right) &= u\left(x_{a,i}\right) + \beta u\left(y_{a,i}\right) \\ &= u_{a,1}\left(\omega_i, b_{w,i}\right) + \beta u_{a,2}\left(f_i, A_i, b_{a,i}, r\right) \quad (8) \end{aligned}$$

$$\begin{aligned} s.t.\ x_{a,i} &= \omega_i + b_{a,i} \\ y_{a,i} &= f_i A_i - r b_{a,i} \\ b_{a,i} &\leq \bar{b}_i \\ A_i &\leq \bar{A}_i \\ 0 &\leq x_{a,i},\ y_{a,i}, A_i, b_{a,i} \end{aligned}$$

Since farmers do not invest, the consumption of farmers in the first period is the same as that of workers. Farmers can only allocate funds through savings and loans, denoted by $\omega_i + b_{a,i}$. Consumption in the second period is farm income minus loan ($f_i A_i - r b_{a,i}$), where farm income is the product of the land owned amount ($A_i$) and output value per unit of land($f_i$).

First, we determine the optimal loan. Farmers allocate funds across time based on loans ($b_{a,i}$). We can obtain the optimal loan $b^*_{a,i}$ when the first-order partial derivative is 0, and $b^*_{a,i}$ satisfies $U'\left(b^*_{a,i}\right) \geq 0$ [refer to Eq. (9)]. Specifically, when $b^*_{a,i} \in [0, \bar{b}_i]$, $U'\left(b^*_{a,i}\right) = 0$. Otherwise, $U'\left(b^*_{a,i}\right) > 0$ and $b^*_{a,i}$ are still the optimal loan:

$$U'_{ai}\left(b_{a,i}\right) = \frac{\partial U_{ai}}{\partial b_{a,i}} = \frac{\partial u(x_{a,i})}{\partial b_{a,i}} + \beta \frac{\partial u(y_{a,i})}{\partial b_{a,i}} \geq 0 \quad (9)$$

Then, we present the indirect utility of the farmer in Eq. (10). The maximum utility of the farmer is determined by $\omega_i$ \ $r$, $A_i$ and, and individual endowments include asset level, acreage and farming skills.

$$V_{ai}\left(\omega_i, f_i, A_i, r\right) = u_{a,1}\left(\omega_i, b^*_{a,i}\right) + \beta u_{a,2}\left(f_i, A_i, b^*_{a,i}, r\right) \quad (10)$$

### 2.2.4 Occupational options

Individuals make decisions based on benefits and costs. If immigration benefits outweigh opportunity costs, then individuals will choose to move. The same is true for the choice of entrepreneurship. We argue that endowments, preference characteristics, and the external environment combine to determine the career choice of individuals. Individuals make occupational options to maximize their effects, and the choice of entrepreneurship and other careers (including work and farming) are mutually opportunity costs. In other words, individuals will only start a business if the benefits of doing so are higher than the benefits of work [refer to Eq. (11)]:

$$\begin{aligned} &V_{ei}\left(\omega_i, R_i, r, \emptyset\right) \\ &> \max\{V_{wi}\left(\omega_i, w_i, r\right), V_{ai}\left(\omega_i, f_i, A_i, r\right)\} \quad (11) \end{aligned}$$

Individuals are more likely to choose entrepreneurship if it brings more utility and to choose work or farming if the choice brings more benefits. Therefore, we define the individual occupational choice satisfying Eq. (12). We use $\pi$ in Eq. (13) to measure the difference between the indirect utility of the two choices.

$$E_i = \begin{cases} 1, & if\ \pi > 0 \\ 0, & if\ \pi < 0 \end{cases} \quad (12)$$

$$\begin{aligned} \pi_i = &V_{ei}\left(\omega_i, R_i, r, \emptyset\right) \\ &-\max\{V_{wi}\left(\omega_i, w_i, r\right), V_{ai}\left(\omega_i, f_i, A_i, r\right)\} \quad (13) \end{aligned}$$

Based on the above model, we discuss that factors would impact an individual's career choice based on comparative static analysis, the individual would choose entrepreneurship when $\pi_i > 0$. Therefore, we can find if $\pi$ has a positive first-order partial derivative for a given factor, the factor has a positive pro-entrepreneurial effect, otherwise, it will inhibit entrepreneurship.

According to the career choice model, people make their career choices by comparing the utility of different occupations. Moreover, through the career choice model, it is possible to better judge the impact of rural return migrants on entrepreneurship. We argue that the rural return migrants are not only the return of labor itself but also the flow of various

factors of production such as knowledge, skills, and capital. The flow of factors brought about by labor mobility optimizes the conditions for residents to start their own businesses, influencing their career choices and, thus, increasing their probability of starting a business. Therefore, we develop the following hypothesis:

> Hypothesis 1: Rural return migrants can increase the probability of entrepreneurship among returning labor.

## 2.3 Mechanisms

### 2.3.1 Land circulation

The difference between rural and urban labor migrants is the land. The opportunity cost of working outside the home is the benefit that farmers can derive from the land. As rural residents own more land, they are less likely to choose to migrate (Hu et al., 2011). In addition, the departure of rural residents, especially young and strong laborers, will lead to the abandonment of the land they would otherwise own. This may result in the outgoing residents renting or even selling the land they own for a higher return, while such laborers will face the dilemma of having less land when they return, directly reducing their probability of farming. Residents who might otherwise choose to work in agriculture give up farming, and this affects their occupational choice as in Eq. (14):

$$\frac{\partial \pi_i}{\partial A_i} = -\frac{\partial V_{ai}\left(\omega_i, f_i, A_i, r\right)}{\partial A_i} = -\frac{\partial u\left(y_{a,i}\right)}{\partial y_{a,i}}\frac{\partial y_{a,i}}{\partial A_i} = -f_i\frac{\partial u\left(y_{a,i}\right)}{\partial y_{a,i}} \tag{14}$$

Where $f_i$ is the individual farming efficiency. We assume that the labor input must lead to the land output, thus, the farming efficiency is constantly positive. According to $u'(y_{a,i})0$, so $\frac{\partial \pi_i}{\partial A_i} < 0$ holds constant. Therefore, labor migration may lead to land circulation with a decrease in the amount of arable land for expatriates ($\Delta A_i < 0$) and further promote an increased choice of entrepreneurship among rural return migrants ($\Delta \pi_i > 0$). Farmers who work outside have a higher likelihood of transferring their land (Kung, 2002). Decisions to shift labor occur before those to transfer farmland. Thus, the outworking experience significantly increases the probability of farmland transfer, and then increases the entrepreneurial probability. The asset-based income generated from the land circulation, together with the wage income from working outside the home, constitutes physical capital, which in turn contributes to the farmers' entrepreneurial performance (Yang and Wen, 2020). Therefore, we develop the following hypothesis:

> Hypothesis 2.1: Working outside the home will decrease land owned by rural residents.

> Hypothesis 2.2: Residents with less land are more likely to start their own businesses.[1]

### 2.3.2 Human capital

The experience of working outside the workplace allows the workforce to gain skills and experience that help them to build human capital (Xu et al., 2017). Specifically, human capital ($k_i$) can be increased in two ways: (i) an increase in the entrepreneurial talent of managers, leading to an increase in the rate of return per unit of investment in entrepreneurship; (ii) an increase in the efficiency of the workforce and an increase in wages. The combined effects are that the rural return migrants will affect human capital accumulation, which in turn will affect entrepreneurship. We find the partial derivative of the entrepreneurship function ($\pi_i$) with respect to human capital ($k_i$), as shown in Eq. (15):

$$\begin{aligned}\frac{\partial \pi_i}{\partial k_i} &= \frac{\partial V_{ei}\left(\omega_i, R_i, r, \emptyset\right)}{\partial k_i} - \frac{\partial V_{wi}\left(\omega_i, w_i, r\right)}{\partial k_i} \\ &= p\beta\frac{\partial u_{e,2}\left(R_i, r\right)}{\partial k_i} - \beta\frac{\partial u_{w,2}\left(w_i, r\right)}{\partial k_i} \\ &= p\beta\frac{\partial u\left(y_{s,i}\right)}{\partial y_{s,i}}\frac{\partial y_{s,i}}{\partial R_i}\frac{\partial R_i}{\partial k_i} - \beta\frac{\partial u\left(y_{w,i}\right)}{\partial y_{w,i}}\frac{\partial y_i}{\partial w_i}\frac{\partial w_i}{\partial k_i}\end{aligned} \tag{15}$$

We can find that the magnitude of the effect of human capital accumulation on residents' entrepreneurial motivation depends on the growth of entrepreneurial income versus wage income as a result of human capital accumulation. Outgoing labor types, the different industries they work in, or the position types they hold will impact individual human capital (Shi and Zhou, 2007; Lee, 2018; Tajpour and Hosseini, 2019). Generally, production activities could increase labor efficiency and management activities increase entrepreneurial talents. The exact increase magnitude is determined by the production and management share of the job. We argue that if rural laborers are engaged in management and administration before they return home, the human capital accumulation will lead to an increase in their entrepreneurial talent and no significant change in individual labor efficiency ($\frac{\partial R_i}{\partial k_i} > 0$, $\frac{\partial w_i}{\partial k_i} = 0$). If rural laborers are engaged in productive work, their entrepreneurial talent will not be accumulated, but labor efficiency will be improved and their wages will rise after they return home ($\frac{\partial R_i}{\partial k_i} = 0$, $\frac{\partial w_i}{\partial k_i} > 0$). Existing studies state that farmers with outworking experience have broader social networks, based on which they can harvest more capital, more customers, and more convenient business permits for entrepreneurship (Xu et al., 2017). The outworking experience significantly improves the probability of starting a business by increasing the human capital accumulation and financing sources for entrepreneurship (Zhou et al., 2017). Therefore, we develop the following hypothesis:

1 We define that financial income by way of land (either in the form of farming or as a farmer) is not entrepreneurship.

> Hypothesis 3.1: Rural return migrants can increase human capital accumulation.

> Hypothesis 3.2: The accumulation of human capital will lead to an increase in productivity and managerial capacity, which together influence the entrepreneurial choices of residents.

### 2.3.3 Physical capital

The lack of capital has always been a major disincentive to entrepreneurship (Batjargal, 2007; Hrytsaienko et al., 2019), and the accumulation of physical capital brought about by the return of labor may affect the motivation of the workforce to start their own businesses. We show the effect using the partial derivative of the entrepreneurship function ($\pi_i$) with respect to physical capital ($\omega_i$), as shown in Eq. (16). The first term in Eq. (16) is the marginal utility from the first period of increased consumption when choosing to start a business, and the second term is the marginal utility from the first period of increased consumption when choosing to work:

$$\begin{aligned}\frac{\partial \pi_i}{\partial \omega_i} &= \frac{\partial V_{ei}(\omega_i, R_i, r, \emptyset)}{\partial \omega_i} - \frac{\partial V_{wi}(\omega_i, w_i, r)}{\partial \omega_i} \\ &= \frac{\partial u(x_{e,i})}{\partial x_{e,i}} \frac{\partial x_{e,i}}{\partial \omega_i} - \frac{\partial u(x_{w,i})}{\partial x_{w,i}} \frac{\partial x_{w,i}}{\partial \omega_i} \\ &= \frac{\partial u(x_{e,i})}{\partial x_{e,i}} - \frac{\partial u(x_{w,i})}{\partial x_{w,i}} \end{aligned} \quad (16)$$

The magnitude of both will influence the effect of physical capital on entrepreneurial motivation, i.e., depending on individual endowments and preferences (Arafat et al., 2020). Increases in physical capital do not directly promote or inhibit the probability of individual entrepreneurship but rather vary according to individual differences. Therefore, we develop the following hypothesis:

> Hypothesis 3.1: Rural return migrants can lead to the accumulation of physical capital.

> Hypothesis 3.2: An increase in physical capital will increase the utility of all career choices, and whether or not it has a facilitating effect on entrepreneurship depends on the size of the increase in utility for different career types.

## 2.4 Entrepreneurial effects of rural return migrants

From the above analysis, we argue that the rural return migrants lead to an increase in the probability of entrepreneurship, expressed as the derivative of the occupational choice function ($\pi$) with respect to the return of resident labor ($M$). We denote the entrepreneurial effect of rural return migrants as $T(M)$, as shown in Eq. (17):

$$\begin{aligned} T(M) &= \frac{\partial \pi}{\partial M} = \frac{\partial \pi}{\partial k}\frac{\partial k}{\partial M} + \frac{\partial \pi}{\partial \omega}\frac{\partial \omega}{\partial M} + \frac{\partial \pi}{\partial A}\frac{\partial A}{\partial M} \\ &= \left[ p\beta \frac{\partial u(y_{s,i})}{\partial y_{s,i}} \frac{\partial y_{s,i}}{\partial R_i} \frac{\partial R_i}{\partial k_i} - \beta \frac{\partial u(y_{w,i})}{\partial y_{w,i}} \frac{\partial y_i}{\partial w_i} \frac{\partial w_i}{\partial k_i} \right] \frac{\partial k}{\partial M} \\ &+ \left[ \frac{\partial u(x_{e,i})}{\partial x_{e,i}} - \frac{\partial u(x_{w,i})}{\partial x_{w,i}} \right] \frac{\partial \omega}{\partial M} - \left[ f_i \frac{\partial u(y_{a,i})}{\partial y_{a,i}} \right] \frac{\partial A}{\partial M} \end{aligned} \quad (17)$$

The entrepreneurial effects of rural return migrants are divided into three categories. The first term, outside the brackets, is the human capital growth brought about by the rural return migrants while the inner bracket is the impact of the human capital growth per unit on entrepreneurship, and the product of the two is the impact of the rural return migrants on entrepreneurship through the human capital path. Similarly, the second and third terms represent the impact of the rural return migrants on entrepreneurship through physical capital accumulation and land circulation, respectively. This implies that the entrepreneurial effect of rural return migrants is the result of the combined effect of human capital, physical capital, and land circulation.

# 3. Methodology

## 3.1 Sample and data

First, we use micro-individual data. Current literature mainly uses macro (Zhang and Cen, 2014; Yingen and Guangli, 2020), micro (Oostendorp, 2017), and big data (Obschonka and Audretsch, 2020). The main reason for abandoning the use of macro data is its difficulty to access. At present, direct macro statistics on population movements are still scarce. Existing studies using macro data are mainly based on "historical census data" (Zhang and Cen, 2014) or use "current resident population –(1 + r) × previous resident population" (Yang and Wen, 2020). This is slightly simplistic and crude. There are also some newer studies that use big data methods to count population movements (Obschonka and Audretsch, 2020), but this measurement is even less applicable to the topic. The reasons for this are: first, this measurement is more ambiguous. Big data reflect an offset of population inflows and outflows, but we focus labor force return, which required defining accurately population inflows and outflows. This measurement approach is very crude. The population flows obtained in this way are only meaningful in terms of current flows, whereas labor returns are a long-term effect and are not suitable for measurement using flow data. Therefore, it is more appropriate to use micro data for this analysis.

Then, we use cross-sectional data. Panel data are the dominant research basis in most existing research, but the use of cross-sectional data in our research is based on two considerations: (i) the way labor returns are asked in the questionnaire is inconsistent across years (Xu et al., 2017), which does not accurately meet the single definition in our research; (ii) changes in the indicator of "whether or not one is a returnee" over time are not obvious in the questionnaires of different years. Only samples that change from non-returning to returning individuals between surveys are valid, and the use of panel fixed effects results in a large number of missing samples. Therefore, following Shi and Yang (2012) and Zhou et al. (2017), we use cross-sectional data for the analysis.

The data are mainly from the CLDS and CHFS, which are used widely (Zhou et al., 2017; Yang and Wen, 2020). The CLDS survey covers all labor force members aged 15–64 in the surveyed households, focusing on the labor force characteristics of respondents, which facilitates further exploration of rural return migrants. We used "whether the rural sample has experience of working outside" as the criterion to determine whether the sample belongs to the labor force return, and "whether the sample has work experience" to determine whether the sample belongs to the labor force, and finally obtained 5,591 samples. The CHFS focuses on the financial attributes of respondents, providing a wealth of data on entrepreneurship, which provides good conditions for analysis at the entrepreneurial level. We use only the data from CHFS to test for the mediating effect of physical capital and obtain 29,339 samples. It was not possible to match the two databases because of the different respondent groups and different coding methods. However, in the empirical part, using two different databases for the study also allows cross-validation, making the results more robust and more credible.

## 3.2 Variables measurement

### 3.2.1 Dependent variables

Entrepreneurship. We use the question "Was the last job an entrepreneur?" to measure whether the sample is entrepreneurial, denoted by *E*. *E* is 1 for entrepreneurs and 0 otherwise.

### 3.2.2 Independent variables

Rural return migrants. We consider that rural return migrants need to meet three conditions: (i) having migrant experience; (ii) Being rural samples; and (iii) being of working age. We define samples as rural return migrants that satisfy the above conditions, denoted by *mig*. *mig* is 1, 0 otherwise.

### 3.2.3 Control variables

Following existing literature, we set control variables at the individual, household, and village levels that may affect entrepreneurial behavior in **Supplementary Appendix 2**.

## 3.3 Empirical models

To examine the direct entrepreneurial effects of rural return migrants, we build the Probit model in Eq. (18) based on the theoretical analysis and research hypothesis in section 2 "Theoretical models and hypotheses," considering that the explanatory variable "resident entrepreneurship" is a 0–1 variable:

$$Pr(E_i) = \alpha + \delta mig_i + \Gamma X_i + \varepsilon_i \quad (18)$$

Where $E_i$ is entrepreneurship. $mig_i$ is the dummy for rural return migrants, and it is the core explanatory variable whose coefficient is denoted by $\delta$. $X_i$ stands for a series of control variables (Refer to **Supplementary Appendix 2**). $\varepsilon_i$ is residual. If $\delta$ is significantly positive, it indicates that the return of rural labor has a positive effect on rural entrepreneurship.

# 4. Results

## 4.1 Descriptive statistics

**Table 1** presents descriptive statistics and shows that 1.04% of the sample start their own business and 23.86% are rural return migrants. The basic profile of the variables is consistent with the distribution: the sample surveyed was between 15 and 91 years old, with an average age of 50 years. The female sample

TABLE 1 Statistics description.

| Variable | *N* | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| *E* | 5,960 | 0.0104 | 0.1015 | 0 | 1 |
| *mig* | 5,960 | 0.2386 | 0.4263 | 0 | 1 |
| Age | 5,951 | 50.5646 | 12.6684 | 15 | 87 |
| Gender | 5,960 | 1.4651 | 0.4988 | 1 | 2 |
| Marital status | 5,960 | 2.1047 | 0.7415 | 1 | 6 |
| Political affiliation | 5,952 | 2.9059 | 0.4231 | 1 | 3 |
| Education | 5,955 | 2.7081 | 1.5239 | 1 | 10 |
| Health | 5,958 | 2.4651 | 1.0070 | 1 | 5 |
| Household size | 5,960 | 1.6951 | 0.3600 | 0.6931 | 2.9444 |
| Household savings | 5,953 | 1.9189 | 0.2731 | 1 | 2 |
| Household income | 5,647 | 9.9103 | 2.0391 | 0.0000 | 14.2210 |
| Village size | 5,960 | 6.3395 | 0.7765 | 4.0431 | 9.0807 |
| Village location | 5,960 | 3.0243 | 0.8444 | 0 | 5.70711 |
| Village level | 5,960 | 1.8534 | 0.3538 | 1 | 2 |

There are slight differences in the sample sizes of the variables due to missing variables. We logarithmise the two metrics are not applicable to our research amount. Core explanatory and explained variables are 1 for yes and 0 for no. Control variables are 1 for yes and 2 for no.

is slightly larger, but the gender ratio is generally more balanced, in line with the aging and feminization of rural areas. The rest of the variables are distributed more normally. Therefore, this paper considers the selection of the sample to be somewhat representative.

## 4.2 Empirical results analysis

Table 2 reports the results of tests of the entrepreneurial effect of the rural return migrants. Without considering control variables, the coefficients of $mig_i$ in columns (1) is 0.3688 and significant at the 1% level. This means rural return migrants are 36.88% more likely to start a business than rural residents on average. The coefficients of $mig_i$ in columns (2)–(4) are 0.2690, 0.3238, and 0.3491, respectively, controlling for individual, household, and village characteristics of the sample and are significant at least at the 5% level. We believe that the rural return migrants have a higher incentive to start a business, and the results are somewhat robust as they still hold control over other variables.

TABLE 2 Regression results.

| Variables | (1)*E* | (2)*E* | (3)*E* | (4)*E* |
|---|---|---|---|---|
| *mig* | 0.3688*** (0.101) | 0.2690** (0.112) | 0.3238*** (0.125) | 0.3491*** (0.123) |
| Age | | −0.0087** (0.004) | −0.0071 (0.005) | −0.0069 (0.005) |
| Gender | | −0.3558*** (0.110) | −0.3941*** (0.128) | −0.3982*** (0.129) |
| Marriage | | −0.0854* (0.045) | −0.0822 (0.056) | −0.0868 (0.056) |
| Political affiliation | | 0.0492 (0.124) | 0.0559 (0.123) | 0.0572 (0.120) |
| Education | | 0.0629** (0.028) | −0.0286 (0.033) | −0.0335 (0.034) |
| Health | | −0.1187** (0.060) | −0.0406 (0.073) | −0.0334 (0.074) |
| Household size | | | −0.2330 (0.160) | −0.2263 (0.163) |
| Household savings | | | −0.3802** (0.149) | −0.4159*** (0.154) |
| Household income | | | 0.5132*** (0.073) | 0.4996*** (0.073) |
| Village size | | | | 0.0445 (0.061) |
| Village location | | | | −0.1105* (0.060) |
| Village level | | | | −0.0057 (0.161) |
| Con | −2.4169*** (0.060) | −1.3900*** (0.524) | −5.8274*** (0.910) | −5.5870*** (1.025) |
| *N* | 5,960 | 5,936 | 5,621 | 5,591 |
| $R^2$ | 0.0181 | 0.0759 | 0.192 | 0.197 |

Supplementary Appendix 2 provides definitions of control variables. Robust standard errors in brackets, ***, **, and * denote significance at the 1, 5, and 10% statistical levels, respectively.

## 4.3 Robustness checks

### 4.3.1 Alternative measurement

First, we use the migration experience to re-measure rural return migrants, dividing the cross-county sample into those with cross-township and those with non-township migration experiences. We also use the self-employed to re-measure entrepreneurship. We believe that entrepreneurship is defined as a person who makes an initial investment in the business and can bear the returns and risks. Therefore, we relax the original entrepreneurship condition by defining both "employer" and "Self-employed" as entrepreneurs (the original indicator only defined employers as entrepreneurs, expressed as "Business") and define other employment statuses as non-entrepreneurs. Robustness test results in Table 3 show that the results are still significant at least at the 5% level, and the coefficients of *mig* and migration experience are around 0.3 migration experience, which consists of previous empirical research results.

### 4.3.2 Alternative models

Considering that there may be cases where the sample does not meet the assumptions of the Probit regression, we estimate the coefficients using alternative estimation methods such as Logit, OLS, and GMM. From the robustness test results in Table 4, we can see that changing the models does not affect the previous empirical research results.

### 4.3.3 Sample changes

We use different criteria to redefine the workforce. First, we use the working experience as a criterion and consider

TABLE 3 Alternative measurement.

| Variables | Business | | Self-employment | |
|---|---|---|---|---|
| | (1)*E* | (2)*E* | (3)*E* | (4)*E* |
| *mig* | 0.3491*** (0.123) | | 0.2603*** (0.060) | |
| Migration experience | | 0.3013** (0.119) | | 0.2181*** (0.058) |
| Controls | Yes | Yes | Yes | Yes |
| Con | −5.5870*** (1.025) | −5.5600*** (1.022) | −2.0854*** (0.514) | −2.0821*** (0.514) |
| *N* | 5,591 | 5,591 | 5,591 | 5,591 |
| $R^2$ | 0.197 | 0.195 | 0.0749 | 0.0735 |

Robust standard errors in brackets, ***, **, and * denote significant at the 1, 5, and 10% statistical levels, respectively.

TABLE 4 Alternative models.

| Variables | Probit | Logit | OLS | GMM |
|---|---|---|---|---|
| | (1)*E* | (2)*E* | (3)*E* | (4)*E* |
| *mig* | 0.3491*** (0.123) | 0.7783*** (0.301) | 0.0077** (0.003) | 0.0077* (0.004) |
| Controls | Yes | Yes | Yes | Yes |
| Con | −5.5870*** (1.025) | −12.6021*** (2.387) | 0.0306 (0.023) | 0.0306 (0.023) |
| *N* | 5,591 | 5,591 | 5,591 | 5,591 |
| $R^2$ | 0.197 | 0.196 | 0.014 | \ |

Robust standard errors in brackets, ***, **, and * denote significant at the 1, 5, and 10% statistical levels, respectively.

that the sample only needs to meet the requirement of having work experience without age limits. We then redefine the workforce by working population aged 15–64 and with working experience. Retirement age is the third criterion, and the sample is not below the legal retirement age in the current year, but also with working experience.[2] The robustness results are shown in Table 5 and are consistent with previous empirical research results.

## 4.4 Endogeneity

### 4.4.1 Instrumental variable regression

To further alleviate endogeneity caused by reverse causality and omitted variables, we use village returners' proportion as an instrumental variable (Wahba and Zenou, 2012) in a 2SLS regression to address endogeneity. Both outworking and returning home have network effects, especially in rural areas. One person's going out to work (returning home) may lead to others going out (returning home). Therefore, we believe that the proportion of village returners is correlated with entrepreneurship. Furthermore, the return rate of villages as a whole does not affect the probability of individual residents starting a business. The results of the two-stage instrumental variable regression are shown in Table 6. Panels A and B show the second and first-stage regressions, respectively. Column (1) shows the results of the instrumental variables regression in the base regression, and columns (2)–(4) show the results of robustness tests using different measures of entrepreneurship and rural return migrants, respectively. Panel B shows Residents of regions with higher rates of return have a stronger propensity to return, satisfying the correlation hypothesis of the instrumental variable. Panel A shows the coefficients of *mig* and migration experience both remain significant and positive. The results indicate that our findings do not appear to be driven by endogeneity.

### 4.4.2 Propensity score matching (PSM)

We used all the control variables in the previous section as covariates and matched them using kernel matching, nearest neighbor matching, and caliper matching, respectively, and regressed the matched samples.[3] The results in Table 7 show that there is a significant difference in the probability of starting a business between the treatment and control groups, regardless of the matching method used. Moreover, the effect of rural return migrants on resident entrepreneurship remains positively significant when regressed using the matched samples. With the exclusion of sample self-selection bias, the results remain largely unchanged, and rural return migrants are a significant boost to resident entrepreneurship.

# 5. Mechanisms

## 5.1 Land circulation

We use the *land* to denote land transfers, measured by the area of land owned by individuals and logged. Following Baron and Kenny (1986), we build on the previous findings by conducting a further test, the results are shown in Table 8. In column (1), the coefficient of *mig* is −0.0936 and significant at a 1% level, indicating that rural return migrants with experience of working outside the home tend to have less land per capita than other residents and that there is land circulation among rural return migrants. In column (2), the coefficient of *mig* is significantly positive, and the coefficient of *land* is significantly negative, indicating that the rural return migrants can promote entrepreneurship through land circulation.

2 The regulations in 2018 provide for retirement at age 60 for men and 50 for women.

3 The results of our tests using nearest neighbor sizes (n = 3, 4, 5, 6) and caliper values (cal = 0.03, 0.04, 0.05, 0.06) remain robust and are not listed here due to space constraints and are available upon request.

TABLE 5 Sample changes.

| Variables | Working experience | Working population | Retirement age |
|---|---|---|---|
| | (1)*E* | (2)*E* | (3)*E* |
| *mig* | 0.3491*** (0.123) | 0.3661*** (0.125) | 0.3266** (0.131) |
| Controls | Yes | Yes | Yes |
| Con | −5.5870*** (1.025) | −5.7787*** (1.091) | −5.7527*** (1.157) |
| *N* | 5,591 | 4,877 | 3,495 |
| $R^2$ | 0.197 | 0.191 | 0.165 |

Robust standard errors in brackets, ***, **, and * denote significance at the 1, 5, and 10% statistical levels, respectively.

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TABLE 6 IV- 2SLS.

| Variables | Business | Self-employment | Business | Self-employment |
|---|---|---|---|---|
| | (1)*E* | (2)*E* | (3)*E* | (4)*E* |
| Panel A: second stage | | | | |
| *mig* | 0.6461* (0.389) | 0.8414*** (0.169) | | |
| Migration experience | | | 0.6517* (0.374) | 0.8264*** (0.163) |
| Controls | Yes | Yes | Yes | Yes |
| Con | −5.6829*** (1.131) | −2.2186*** (0.474) | −5.6705*** (1.123) | −2.2268*** (0.471) |
| Panel B: first stage | | | | |
| Returners proportion | 0.9881*** (0.036) | 0.9881*** (0.036) | 1.0091*** (0.038) | 1.0091*** (0.038) |
| Controls | Yes | Yes | Yes | Yes |
| Con | 0.4582*** (0.086) | 0.4582*** (0.086) | 0.4874*** (0.091) | 0.4874*** (0.091) |
| *N* | 5,591 | 5,591 | 5,591 | 5,591 |

Robust standard errors in brackets, ***, **, and * denote significance at the 1, 5, and 10% statistical levels, respectively.

## 5.2 Human capital

Human capital is a factor of entrepreneurship and measures human capital in terms of individual competencies (Xu et al., 2017). An individual's ability is matched by the difficulty of competency in a job. As an individual's ability increases, the individual can obtain a job that matches his or her ability through promotion, job-hopping, and changing job content. We thus equate job difficulty with individual ability, denoted as *abli* and include it as a mediating variable in the regression model.

Table 8 reports the results of the mechanism test for human capital. The coefficient of *mig* in column (3) is 0.0348 and significant at 1% level, indicating that the experience of working away from home has led to a higher level of personal competence in the returning workforce, and it is reflected in the increased difficulty in performing the job. Column (4) incorporates both the core explanatory variables and the mediating variables into the regression model. The coefficient of *mig* is significantly positive and the coefficient of *abli* in column (4) is significantly negative. The results show that the effects of rural return migrants on entrepreneurship remain significant when also controlling for individual capabilities, suggesting that rural return migrants still have a facilitating effect on entrepreneurship and that human capital plays a part in mediating the effect.

## 5.3 Physical capital

We use *save* to measure the physical capital formed by rural return migrants working outside the home. In China, the vast majority of entrepreneurship and work is a household activity, so the use of household savings provides some indication of an individual's physical capital, and the results obtained using household data are credible. We, thus, use the balance of savings in a current account to measure *save*. To mitigate problems such as heteroskedasticity, we add 1 to it and take the logarithm. Columns (5)–(7) in Table 8 show the results of the test for the mediating effect of physical capital. The results in column (5) show that the rural return migrants have a higher entrepreneurial motivation with a coefficient of 0.1580. The coefficient of *mig* is significantly positive in columns (6) and suggests rural return migrants tend to have higher physical capital. Specifically, it is 0.1763% higher and significant at the 1%

TABLE 7 Propensity score matching results.

| Variables | Business | | | Self-employment | | |
|---|---|---|---|---|---|---|
| | Kernel | Nearest neighbor ($n = 5$) | Caliper ($cal = 0.05$) | Kernel | Nearest neighbor ($n = 5$) | Caliper ($cal = 0.05$) |
| | (1)*E* | (2)*E* | (3)*E* | (4)*E* | (5)*E* | (6)*E* |
| *ATT* | 0.0076 | 0.0088 | 0.0075 | 0.0366 | 0.0416 | 0.0368 |
| *t* | 1.75 | 1.90 | 1.75 | 3.48 | 3.68 | 3.50 |
| *mig* | 0.2881** (0.119) | 0.3622*** (0.131) | 0.2891** (0.119) | 0.2613*** (0.062) | 0.3622*** (0.131) | 0.2891** (0.119) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Con | −6.4562*** (1.225) | −7.0850*** (1.332) | −6.4616*** (1.225) | −2.7067*** (0.628) | −7.0850*** (1.332) | −6.4616*** (1.225) |
| *N* | 5,589 | 3,750 | 5,589 | 5,589 | 3,750 | 5,589 |
| $R^2$ | 0.152 | 0.180 | 0.152 | 0.0670 | 0.180 | 0.152 |

Robust standard errors in brackets, ***, **, and * denote significance at the 1, 5, and 10% statistical levels, respectively. The explanatory variables in columns (1)–(3) are business (consider employing others as entrepreneurship only); columns (4)–(6) are self-employment (consider both employment and self-employment as entrepreneurship).

TABLE 8 Mechanisms.

| Variables | Land circulation | | Human capital | | Physical capital | | |
|---|---|---|---|---|---|---|---|
| | (1)*land* | (2)*E* | (3)*abli* | (4)*E* | (5)*E* | (6)*save* | (7)*E* |
| *mig* | −0.0936*** (0.027) | 0.3134** (0.126) | 0.0348*** (0.009) | 0.3395** (0.132) | 0.1580*** (0.043) | 0.1763*** (0.061) | 0.1646*** (0.046) |
| *land* | | −0.1833** (0.092) | | | | | |
| *abli* | | | | 0.0763* (0.040) | | | |
| *save* | | | | | | | 0.0248*** (0.006) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Con | 3.1818*** (0.201) | −5.3772*** (1.154) | 4.2096*** (0.378) | −5.6972*** (1.123) | −1.5664*** (0.230) | 7.8901*** (0.298) | −1.6806*** (0.259) |
| *N* | 5,539 | 5,539 | 4,644 | 4,644 | 40,697 | 29,339 | 29,339 |
| $R^2$ | 0.109 | 0.229 | 0.063 | 0.192 | 0.090 | 0.081 | 0.086 |

Robust standard errors in brackets, ***, **, and * denote significance at the 1, 5, and 10% statistical levels, respectively.

level. Column (7) explores the effect of rural return migrants on entrepreneurial intentions, controlling for physical capital, and finds that the results remain significant. This suggests that while physical capital plays a mediating role, again it is only partially mediated.

## 6. Conclusion and implications

Entrepreneurship is generally recognized as a key component in the development process and especially a scarce resource in economically disadvantaged rural areas. The return of rural labor outside the home is related to the promotion of urbanization and the implementation of the rural revitalization strategy and is of great importance to regional economic development. We first theoretically reveal the mechanism of occupational choice and the entrepreneurial propensity of rural return migrants under different occupational returns by constructing an occupational choice model of rural return migrants, and then empirically test the relationship between rural return migrants and entrepreneurial effect using CLDS (2018) and CHFS (2019). The results show that rural return migrants have a positive effect on entrepreneurship, and this effect still holds when controlling for the remaining variable and this finding holds after accounting for endogeneity. We further find that land circulation, human capital, and physical capital are stimulating factors in promoting rural entrepreneurial activities of rural return migrants, and there is a threshold effect on physical capital.

Based on the results, we put forward the following targeted policy recommendations for the rural labor return in China: first, following the trend of labor force return, the base of the entrepreneurial group should be enlarged. The government should seize the opportunity of rural revitalization, build a platform for employment and entrepreneurship based on industrial development, and expand the development space with entrepreneurship support policies as a guarantee. The aging of rural areas is becoming increasingly serious and fertility growth is not promising. The government should take measures to increase the birth rate in rural areas and strengthen the security of retirement, health care, and education in rural areas to provide the basis for a larger rural entrepreneurial group.

Second, it is important to improve the land circulation model and increase the willingness of rural residents to start their businesses. Establish a clear system of property rights and adhere to, consolidate, and improve relevant land policies. Meanwhile, the market-based mechanism of land circulation should be used rationally, and the owners of rural land should be actively guided to use market-based means to obtain the proceeds of land circulation. It is important to strike a balance between efficiency and fairness in the process of land transfer and to prevent the polarization of the income of rural residents. The direction of land circulation is to obtain a continuous increase in marginal returns through increased productivity and industrial development on the premise of a moderate scale.

Third, human capital should be strengthened to provide intellectual support for rural residents to start their businesses. At present, the education, skill, and business management levels of rural labor are low as a whole. The lack of human capital will limit the willingness of rural residents to start their businesses and the scale of entrepreneurship. For the rural return migrants, improving human capital is not a short-term quick fix, and the government should pay attention to it at all stages. It is necessary to increase financial investment in basic education in rural areas, strengthen the policy inclination for rural students in vocational and higher education, and encourage social forces to participate in rural education in various forms.

Finally, the accumulation of physical capital should be valued to provide sufficient funds for rural residents to start their businesses. The government should take measures to narrow the income gap within rural areas and broaden the sources of income for rural residents through market-based means. Meanwhile, the government should encourage rural residents to expand their consumption and improve their consumption

structure. The government should tap and release the huge consumption potential in rural areas so that consumption can drive production, and production can drive investment and entrepreneurship.

Policymakers should consider the psychological effects of changes in the economic environment of migrant workers who go out to work and the economic consequences of their return to rural. Entrepreneurship should be paid attention to as an important tool to drive rural economic development. Neglecting rural migrants' entrepreneurship is not conducive to sustainable rural development. We are committed to developing a complete and insightful understanding of rural return migrants and their entrepreneurial effects. However, it must be acknowledged that the theoretical and empirical analysis in this paper has been done in the context of a low volume of relevant literature and insufficient experience, due to the relatively small amount of existing research and experience. Data on rural return labor have limitations at both the macro and micro levels. Due to a lack of statistical data, we are unable to provide an accurate count of the number of people in this group. We, therefore, expect to make greater use of mathematical language in future research to complete the derivation of the entrepreneurial effects of rural return labor and to provide scientific evidence to support this topic. Entrepreneurship is becoming increasingly important in economic development, and there are differences in rural development across China and around the world. We believe that this theme will be a hot topic for academic research, with a vertical analysis of the time characteristics and a horizontal analysis of the regional differences, as well as an analysis of how to support and protect the entrepreneurial behavior of rural return migrants on the basis of the economic and social risks arising from large-scale population movements.

## Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The data will be used in subsequent studies. Requests to access these datasets should be directed to corresponding author.

## Author contributions

AB and GP contributed to the conception, design, and formal analysis of the study. AB performed the methodology, software, data curation, and writing – original draft preparation. GP performed the validation, investigation, and writing – review and editing. GZ performed the writing – review and editing and supervision. All authors contributed to manuscript revision, read, and approved the submitted version.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.1078199/full#supplementary-material

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# How responsible leadership shapes followers' low-carbon behavior: A dual-mediation model

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**Introduction:** In recent years, environmental problems such as global warming, rising sea levels, and species extinction have provoked a widespread concern all over the world, and many countries and international organizations have called for a reduction in carbon emissions. Theoretically, although many scholars have explored how responsible leadership influences subordinates' work-related outcomes, little studies have examined the association between responsible leadership and employees' low-carbon behavior. Therefore, to address this literature gap, we here drawing upon social cognitive theory developed a dual-mediation model to investigate how responsible leadership impacts employees' low-carbon behavior, and through which mechanisms this impact may occur.

**Methods:** By conducting a questionnaire survey in a company in China, we collected the valid data from 411 samples. Then using SPSS 26.0 and Mplus 8.1, we tested our proposed theoretical model and hypotheses by analyzing these data.

**Results:** The empirical results showed that responsible leadership was positively related to employees' environmental consciousness, which can further increase their low-carbon behavior. At the same time, responsible leadership was negatively related to employees' environmental apathy, which can reduce their low-carbon behavior. And employees' environmental consciousness and environmental apathy played the mediating roles in the relationship between responsible leadership and employees' low-carbon behavior. Furthermore, we found that leader-member exchange (LMX) magnified the direct effect of responsible leadership on employees' environmental apathy and strengthened the indirect effect of responsible leadership on employees' low-carbon behavior via environmental apathy, but the moderating effect of LMX on another path was not significant.

**Discussion:** These findings suggest that despite encouraging leaders to show responsible behaviors, promoting employees' environmental consciousness and reducing their environmental apathy may be useful ways to facilitating their low-carbon behavior and achieving a low-carbon society. Moreover, establishing a high-quality of exchange relationship with followers may magnify the effectiveness of responsible leadership on lowering followers' environmental apathy.

KEYWORDS

**responsible leadership, environmental consciousness, environmental apathy, low-carbon behavior, leader-member exchange, social cognitive theory**

## Introduction

Recently, the research topic of responsible leadership has been attracting increased scholarly attention in the field of organizational behavior (Waldman and Galvin, 2008; Doh and Quigley, 2014; Dong and Zhong, 2022). Responsible leadership is a social and moral phenomenon that occurs in social processes of interaction (Maak and Pless, 2006a; Pless et al., 2012), defined as a "values-based and through ethical principles driven relationship between leaders and stakeholders who are connected through a shared sense of meaning and purpose through which they raise one another to higher levels of motivation and commitment for achieving sustainable values creation and social change" (Pless, 2007, p: 438). It was conceptualized on the basis of the intersection of corporate social responsibility and leadership literature (Doh and Quigley, 2014; Waldman and Balven, 2014). As an emerging leadership style, the most important difference between responsible leadership and other classical leadership styles, such as servant leadership, transformation leadership, humble leadership, authentic leadership, or ethical leadership, is its core notion of responsibility. That is, responsible leadership aims at not only facilitating employees' positive outcomes, but also making the organizations responsible (Haque et al., 2019a,b).

Indeed, existing studies have drawn the conclusion that responsible leadership could generate desirable outcomes in the organizations. Specifically, as a form of value-based leadership style, responsible leadership has been found to be effective in promoting employees' work-related attitudes and behaviors. For example, empirical research has showed the positive associations between responsible leadership and employees' higher organizational commitment (Haque et al., 2019a), lower intention to quit (Haque et al., 2019b; Yasin et al., 2021), less unethical pro-organizational behavior (Cheng et al., 2019), and greater work engagement (Dong and Zhong, 2022). Besides, scholars also verified the significant effects of responsible leadership on performance. For instance, Lin et al. (2020) suggested that responsible leadership could positively influence employees' job performance through the mediators of work engagement and helping initiatives. Javed et al. (2021) then confirmed the positive relationship between responsible leadership and corporate social performance at a firm level. Although great progress has been achieved in this field, how responsible leadership impacts employees' low-carbon behavior still remains unresolved.

We believe that it is necessary to explore the influence of responsible leadership on employees' low-carbon behavior. That is because, on the one hand, coping with this issue may theoretically enrich our understanding of the consequence of responsible leadership for employees' non-work behaviors, and provide some guidances for organizations fostering responsible leaders. On the other hand, examining the predictors of employees' low-carbon behavior has important practical implications. Specifically, recently environmental problems such as global warming, rising sea levels, extreme weather, and air pollution have becoming more serious and frequent than before, pushing many organizations and countries take actions or set policies in order to achieve low-carbon, green, and sustainable development (Arora et al., 2018). The Chinese government has announced the plan that China will aim to reach peak carbon dioxide emissions by 2030, and strive to achieve carbon neutrality by 2060. And research has indicated that the carbon emission of individuals' daily behaviors accounts for around 80% of the total amount of global carbon emission (Bin and Dowlatabadi, 2005; Xia et al., 2022). Therefore, under such a context, it is essential to improve individuals' low-carbon awareness and increase low-carbon behavior.

In this study, to fill this literature gap, we develop a dual-mediation model to investigate whether, how, and under which conditions responsible leadership may influence employees' low-carbon behavior. The conceptual model in this study is based on social cognitive theory, which illustrates the interaction effects between external environment factor, individuals' cognition, and individuals' behavior (Bandura, 1986). One of the central propositions in social cognitive theory is external environment factors could exert a direct effect on individuals' subjective cognitions, which then could shape their behavioral outcomes (Bandura, 1986, 2008). We believe social cognitive theory is a suitable framework to support our conceptual model as it has been found that leadership style can be viewed as an important external environment factor, which significantly impacted their followers' subjective perceptions and behaviors (Pan, 2021; Deng et al., 2022). Thus, consistent with previous studies, we argue that responsible leadership may also have profound implications for employees' cognitions and behaviors. More specifically, responsible leadership pays close attention to "society, the environment, sustainable value creation and positive change" (Han et al., 2019a, p: 306) and aims to achieving the coordinated development between people, society, and nature (Pless et al., 2011). In addition, responsible leaders not only practice social responsibility actively, but also set an example for their followers to focus on environmental issues and engage in environmental behavior (Pless, 2007; Han et al., 2019b). Given that leaders' behaviors can affect their subordinates through daily interactions, we speculate that supervised by responsible leadership, employees' environmental consciousness will be enhanced, which in turn, induces their low-carbon behavior. Meanwhile, we also propose that responsible leadership negatively predicts employees' environmental apathy, which may have a negative association with their low-carbon behavior.

Besides, we go a step further to explore the boundary conditions that may alter the extent of responsible leadership influences employees' cognitions and behaviors. According to social cognitive theory, employees' individual difference may influence the process of environmental factors impacting individuals' cognitions and behaviors (Wood and Bandura, 1989). Therefore, in this study, we propose that an individual characteristic in the organizational context, leader-member exchange (LMX), may play a moderating effect on the relationship between responsible leadership and employees' outcomes.

Followers' perceived the quality of their exchange relationship with supervisors can be viewed as a salient individual feature that will affect the degree of their acceptance of responsible leaders as a role model, their identification of responsible leaders' behaviors, and their willingness to follow responsible leaders. All these effects will be reflected on the employees' responses to responsible leadership. In particular, we predict that employees with a high-quality of LMX relationship will be more likely to be affected by responsible leadership. That is, LMX positively moderates the relationships between responsible leadership and employees' environmental consciousness and environmental apathy, and subsequently, moderates the indirect effect of responsible leadership on employees' low-carbon behavior *via* environmental consciousness and environmental apathy. Figure 1 shows the theoretical model.

This study makes several theoretical contributions to current literature on responsible leadership and low-carbon behavior. Specifically, we firstly extend responsible leadership literature by shedding light on the effect of responsible leadership on molding employees' low-carbon behavior. Although many previous studies have investigated the influences of responsible leadership on their subordinates' work-related attitudes and behaviors, we know surprisingly little about how responsible leadership impacts their followers' low-carbon behavior. By examining this association, it is also very helpful to deepen our knowledge of the antecedents of employees' low-carbon behavior. In addition, based on social cognitive theory, we build a dual-mediation model to uncover the underlying mechanism through which responsible leadership may impact employees' low-carbon behavior. In particular, we identify employees' environmental consciousness and environmental apathy as the potential mediators that may link responsible leadership to employees' low-carbon behavior. By doing so, we provide a new sight on understanding the consequences of responsible leadership for employees from the cognitive perspective. Moreover, we contribute to the current literature by exploring the boundary condition that may constrain the effect of responsible leadership on employees' cognition and low-carbon behavior. Here, we examine the moderating effect of LMX on the direct relationships between responsible leadership and employees' environmental consciousness and environmental apathy, as well as the indirect relationship between responsible leadership and employees' low-carbon behavior *via* environmental consciousness and environmental apathy. Overall, we paint a more complete picture by clarifying under which conditions responsible leadership may maximally foster employees' low-carbon behavior.

## Theory and hypotheses

### The mediating role of employees' environmental consciousness

Responsible leadership is an emerging leadership style in which leaders build and sustain positive relationship with both of internal and external stakeholders to the organizations (Maak and Pless, 2006b). The stakeholders include employees, customers, communities, environment, suppliers, etc. (Pless, 2007). From the notion of responsible leadership, unlike other leadership approaches, responsible leadership aims at reaching the probable balance between achieving profit maximization and undertaking societal or environmental responsibilities (Miska et al., 2014), which reflects the inherent challenges and difficulties in responsible leadership. Environmental consciousness refers to the extent to which individuals' beliefs value environmental problems (Ahmad et al., 2020). It reflects individuals' attitudes toward their own behavior or others' behavior with environmental consequences.

According to social cognitive theory, environmental factors can shape individuals' subjective cognitions and further behaviors (Bandura, 1986, 2008). In the context of organizations, as followers and their leaders frequently interact with each other in daily work, their leaders' behavioral styles may be an important external environmental factor in impacting followers' perceptions and behaviors. Besides, existing studies have used social cognitive theory to explore the influences of leadership on employees' outcomes. For

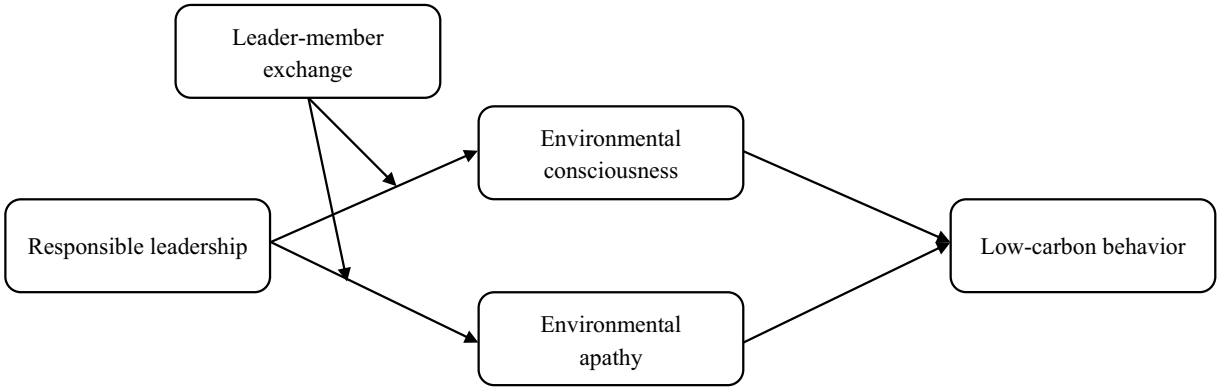


FIGURE 1
The theoretical model.

example, Pan (2021) indicated the profound significance of paradoxical leadership in affecting followers' paradoxical mindset and personal service orientation, and distal behavioral outcomes (i.e., OCB; Pan, 2021). And in one recent study, Deng et al. (2022) showed that ethic leadership could positively increase followers' moral elevation and then their peer monitoring behavior (Deng et al., 2022). Thus, consistent with existing research, we propose that employees' environmental consciousness may be a cognitive mechanism in explaining the relationship between responsible leadership and employees' low-carbon behavior. In this section, we argue that responsible leadership may be positively associated with employees' environmental consciousness.

First, as we noted above, responsible leaders not only focus on the organizations' customers, suppliers, and community, but also see the natural environment as an important stakeholder. In other words, responsible leadership seeks the harmony between people, society, and environment. This may increase employees' attention for environmental issues, their obligation for environmental protection, and corporate social responsibilities, thus promoting their environmental consciousness. Second, responsible leadership delivers a strong signal that they value environmental problems and sets a role model for the employees for actively engaging in eco-friendly behaviors. From the perspective of social learning, employees can observe and imitate leaders' behaviors, finally internalize leaders' values and thus increase their green shared vision. Furthermore, existing research has provided a series of evidence for this proposition. For example, many scholars found that responsible leadership could facilitate employees' pro-environmental behavior (Han et al., 2019a,b; Afsar et al., 2020; Abbas et al., 2021; Tuan, 2022) and voluntary workplace green behavior (Zhang et al., 2021). Accordingly, we propose:

> *H1a*: Responsible leadership will be positively related to employees' environmental consciousness.

According to social cognitive theory, individuals' subjective cognitions can shape their external behaviors (Bandura, 1986, 2008). Based on this, we propose that employees' environmental consciousness may mold their low-carbon behavior. Low-carbon behavior refers to the behaviors that are helpful for building a low-carbon society such as using energy-saving appliances or turning off appliances when they are not in use (Whitmarsh et al., 2011). Previous studies have found that low-carbon knowledge (Lin and Yang, 2022), carbon neutrality behavioral intention (Zhao et al., 2022), and low-carbon awareness (Xia et al., 2022) can promote individuals' low-carbon behavior. In this study, we argue that employees' environmental consciousness can foster their low-carbon behavior for the following reasons:

First, environmental consciousness refers to a tendency to mentally reflect on the environment and to psychological conditions that reflect environmental commitment attitudes (Robert and Bacon, 1997). Scholars have noted that individuals with higher levels of environmental consciousness are concerned about the natural environment and are prone to perceive that they are responsible for the environmental protection (Huang et al., 2014). So they are more likely to show low-carbon behavior that has less harmful influence on the environment. Second, in an investigation into the tourists' visiting intentions toward eco-friendly destinations, Ahmad et al. (2020) mentioned that essentially speaking, the idea of environmental consciousness incorporates the explicit psychological factors that link to individuals' inclination to perform eco-friendly behaviors. Therefore, environmental consciousness provides a motivation for individuals to conduct low-carbon behavior. Furthermore, existing literature is in consensus that individuals' high levels of environmental consciousness have the direct effects on their environment-friendly behaviors. For example, Schlegelmilch et al. (1996) found that the individuals endowed with a higher level of environmental consciousness contributed to their green purchasing decisions. Huang et al. (2014) showed that environmental consciousness could positively predict green customer behavior. In sum, we hypothesize:

> *H1b*: Employees' environmental consciousness will positively predict their low-carbon behavior.

Based on social cognitive theory, organizational factors could influence individuals' subjective cognitions and then their subsequent behaviors (Bandura, 1986, 2008). In this study, responsible leadership has a positive influence on employees' environmental consciousness. That is because, responsible leadership not only focuses on pursuing financial interests, but also undertaking environmental responsibilities at the same time (Lu et al., 2022). Through observing leaders' responsible behaviors, employees may be impacted by the values of responsible leadership, and therefore pay a great concern on environmental problems by showing a higher level of environmental consciousness (Han et al., 2019a,b). As a result, elevated environmental consciousness may increase employees' environmental felt-responsibility and motivate employees to conduct more environmental protection behaviors such as pro-environmental behavior, green behavior, or low-carbon behavior (Afsar et al., 2020; Abbas et al., 2021; Zhang et al., 2021). Taken together, we suggest that responsible leaders' behavior can shape employees' low-carbon behavior by molding their subjective cognition (i.e., environmental consciousness). Therefore, we make the following hypothesis:

> *H1c*: Employees' environmental consciousness will mediate the relationship between responsible leadership and employees' low-carbon behavior.

## The mediating role of employees' environmental apathy

After illustrating the mediation effect of employees' environmental consciousness in the relationship between responsible leadership and employees' low-carbon behavior, in this section, we try to reveal another path that may link responsible

leadership to employees' low-carbon behavior. Based on social cognitive theory (Bandura, 1986, 2008), we propose, responsible leadership may significantly influence employees' environmental apathy, and subsequently their low-carbon behavior. Environmental apathy can be viewed as an individuals' subjective cognition, which refers to "a lack of interest in environmental issues, and a general belief that problems in this area have been exaggerated" (Thompson and Barton, 1994, p: 151). Previous research has indicated that individuals' general apathy toward environmental issues may be influenced by individuals' own competitive worldview and narcissism personality (Abraham and Pane, 2016), support for free-market ideology (Heath and Gifford, 2006), ecocentrism and anthropocentrism (Thompson and Barton, 1994; Karpiak and Baril, 2008). Here, we argue that the level of employees' environmental apathy may be impacted by their immediate supervisors' responsible leadership style.

Specifically, first, as we mentioned above, responsible leaders aspire to be the true planetary citizens (Pless, 2007). That is, they hold the beliefs that they not only have responsibilities for the organizations' performance, but also should not duck the responsibilities for caring for the environment (Voegtlin et al., 2012). Therefore, in the organizations, responsible leaders may proactively take actions to save material resources based on recycling principle. For example, they may call for using double-sided printing instead of single-sided printing and for the consideration of saving money. Besides, they may show many conserving behaviors such as energy, water or electricity. All of these actions reflect that responsible leadership put great value on environmental protection, thus contributing to awareness raising on ecological environmental issues among employees (Maak and Pless, 2006b). Hence, we speculate that supervised by responsible leaders, employees' environmental apathy may be lowered to some degree. Furthermore, through the daily interaction with employees, responsible leaders will share amount of information about environment issues and highlight the importance of environmental protection. By doing this, employees can enrich their understanding of current conditions of environmental pollution or environmental governance, thus increasing their concerns for the environment. Given that environmental apathy means that individuals do not consider the environmental issues are important (Tortosa-Edo et al., 2014), we suggest that influenced by responsible leadership, employees' apathy toward the environment will be broken effectively. To sum up, we hypothesize:

> *H2a*: Responsible leadership will be negatively related to employees' environmental apathy.

In existing literature, scholars have noted that environmental apathy or indifference is as destructive as other anti-environmental attitudes (Abraham and Pane, 2016). Accordingly, drawing upon social cognitive theory, we propose that employees' environmental apathy may be negatively related to employees' environmentally friendly behaviors such as low-carbon behavior.

Firstly, individuals' apathy toward environmental issues reflects their "carelessness toward the protection and maintenance of the environment" (Gheith, 2013, p: 65). In other words, those individuals with high levels of environmental apathy show less concerns for the environment (Karpiak and Baril, 2008). Therefore, given that their unwillingness to pay attention to environmental issues, they are less likely to invest their personal resource such as time and energy to protect environment, cope with environmental problems, as well as show more pro-environmental behaviors: low-carbon behavior. Secondly, as a result of the individuals' apathy toward environment, they may lack the knowledge about environmental problems, may not make accurate assessment of environmental problems, and thus will not place a high value on environmental protection. Heath and Gifford (2006) indicated that individuals' environmental apathy had a detrimental effect on their beliefs about global climate change. Therefore, such an indifference attitude toward environmental protection may not increase individuals' focus on whether their daily behaviors meet the requirements of environmental protection. Accordingly, they will not be intended to show low-carbon behavior in their daily life. Furthermore, in existing literature, relevant research has provided sufficient evidence for this speculation. For example, Kaltenborn and Bjerke (2002) showed that environmental apathy negatively predicted a preference for farm environments. Casey and Scott (2006) used the sample from Australian and found that level of apathy was negatively correlated with levels of pro-ecological behaviors. And Coşkun et al. (2022) demonstrated that apathy could prevent consumers from considering its environmental characteristic when purchasing products. To sum up, we propose the following hypothesis:

> *H2b*: Employees' environmental apathy will negatively predict their low-carbon behavior.

According to the research on leadership and social cognitive theory, as an important organizational factor, leadership style could cause profound implications for employees' subjective perceptions and behaviors (Deng et al., 2022). In this section, we speculate that responsible leadership may exert a significant effect on employees' low-carbon behavior by reducing their environmental apathy. Specifically, under the supervision of responsible leaders, employees may increase their focus on environmental problems, improve their realization that human beings are the subject of responsibility for protecting ecosystems, and then reduce their environmental apathy (Han et al., 2019b; Afsar et al., 2020; Abbas et al., 2021). When employees' environmental apathy was decreased, they may show great willingness to concern environmental problems and great initiative in displaying environmental protection behaviors (Dai and Chen, 2021). In other words, such internal cognition will push them to exhibit external behaviors that are consistent with their subjective cognition, thus showing more low-carbon behavior. Taken together, we argue that employees' decreased environmental

apathy may be a potential mediator that can link responsible leadership to employees' low-carbon behavior. Therefore, we propose the following hypothesis:

> *H2c*: Employees' environmental apathy will mediate the relationship between responsible leadership and employees' low-carbon behavior.

## The moderating role of leader-member exchange

Leader-member exchange (LMX) refers to the dyadic relationship between a pair of supervisor and follower (Bauer and Green, 1996; Zhang et al., 2020). The formation of a LMX relationship is on the basis of a series of interpersonal interactions and exchanges of work-related resources (Graen and Cashman, 1975; Graen and Scandura, 1987). However, during the different relationship-building processes, two parties may both invest different levels of resources, thus causing the LMX relationships among each pair of supervisor and employee may distinct (Green et al., 1996; Wayne et al., 1997). That is, employees build different quality of exchange relationship with their supervisors, and accordingly, supervisors will not treat their employees in the same way (Zhang et al., 2020). Previous studies have demonstrated that a high-quality of LMX may contribute to employees' innovative behaviors (Basu and Green, 1997), organizational commitment (Lee, 2005), job performance (Breevaart et al., 2015; Martin et al., 2016), and reduced turnover intention (Gara Bach Ouerdian et al., 2021).

Social cognitive theory indicated that individuals' characteristics may influence the process of external environment factor impacting individuals' cognitions and behaviors (Wood and Bandura, 1989). Based on this rationale of social cognitive theory, we propose employees' responses to leadership may depend on the nature of LMX, that is employees' LMX will positively moderate the influences of responsible leadership on their environmental consciousness and environmental apathy. Specifically, first, based on the principle of reciprocity, high-quality LMX relationships are characterized by mutual trust, respect, and liking (Liden and Maslyn, 1998). If employees' LMX are high, they are inclined to perceive that their leaders treat them beyond the requirements of the organizations, show greater identification with or commitment to leaders, and define themselves as the in-group members. To reciprocate leaders' treatment, those employees will be willing to follow leaders' suggestions and requests. Therefore, employees with high LMX are more likely to internalize the values of responsible leadership, manifesting increased environmental consciousness and decreased environmental apathy. Second, employees with high-quality of LMX may keep frequent communications with their supervisors (Dienesch and Liden, 1986). The communications are more likely to deepen the influences of responsible leadership on the employees whose LMX is high, rather than whose LMX is low. Therefore, those employees with high-quality LMX will show more higher environmental consciousness and lower environmental apathy. Furthermore, relevant studies on LMX supported this proposition. For example, Michel and Tews (2016) found that LMX could accentuate the effects of leaders' relations-oriented and change-oriented behaviors on employees' OCB. Besides, Niu et al. (2018) found that LMX positively moderated the relationship between authentic leadership and employees' relational identification with their leader. Overall, we argue that LMX could exaggerate the effectiveness of responsible leadership on employees. Thus, we hypothesize the following:

> *H3a*: The effect of responsible leadership on employees' environmental consciousness will be stronger for employees reporting higher LMX.
>
> *H3b*: The effect of responsible leadership on employees' environmental apathy will be stronger for employees reporting higher LMX.

## Moderated mediation effects

Going a step further, we argue that employees' LMX may moderate the indirect effects of responsible leadership on employees' low-carbon behavior through environmental consciousness and environmental apathy, respectively. As we noted before, employees with high-quality LMX will be more inclined to identify with their supervisors, be more likely to view their supervisors as the role model, and be more willing to imitate their supervisors' behaviors (Tse et al., 2012; Hu and Liden, 2013). Therefore, we believe that the possibility of employees being influenced by responsible leaders is much higher for those employees who report high levels of LMX than those who report lower levels of LMX. In the current study, specifically, for those employees with a high-quality of LMX relationship, the positive effect of responsible leadership on their environmental consciousness and the negative effect of responsible leadership on their environment apathy will be exaggerated as they may internalize the values of responsible leadership effectively, thus reflecting in increased their low-carbon behavior. Accordingly, the mediation effects of environmental consciousness and environment apathy in the relationship between responsible leadership and low-carbon behavior will be strengthened when employees rate a higher level of LMX.

In sum, integrating the preceding discussion regarding the above hypotheses, we contend that for employees with high LMX, the indirect influences of responsible leadership on employees' low-carbon behavior *via* environmental consciousness and environmental apathy will be higher. In contrast, for employees with low LMX, the indirect influences of responsible leadership on employees' low-carbon behavior *via* environmental consciousness and environmental apathy will be lower. Thus, we hypothesize:

*H4a*: The indirect effect of responsible leadership on employees' low-carbon behavior *via* environmental consciousness will be moderated by employees' LMX, such that this indirect effect is stronger when employees' LMX is high, but weaker when employees' LMX is low.

*H4b*: The indirect effect of responsible leadership on employees' low-carbon behavior *via* environmental apathy will be moderated by employees' LMX, such that this indirect effect is stronger when employees' LMX is high, but weaker when employees' LMX is low.

# Materials and methods

## Samples and procedure

The sample of this study was full-time employees who worked in a large-scale manufacturing company in northern China. Manufacturing industry is one of the most representative industries in China. This company manufactured household appliances. We selected this company because it consumed a large amount of material resources, electricity, and energy in its daily production. The majority of our participants were front-line workers who worked in the factories of this company, and the others were employees who worked in a variety of departments, including administration, technology, marketing, finance, and operations. Because of the COVID-19 pandemic, we conducted this survey online. Specifically, first, under the assistant of human resource management department, we obtained the list of participants who were voluntary to join this survey. Then, all participants received an email in which we introduced this questionnaire survey, including explaining the procedure and the purpose of this survey, highlighting the importance of rating their actual feeling, and assuring data confidentiality. Besides, we also invited them to scan a QR code to join our research WeChat group. At the beginning of each wave of the survey, we shared the link of questionnaire in the WeChat group to ask all participants to completing the questionnaire.

To reduce the potential common method bias, we separate our data collection into two waves. At time 1, we asked the participants to report their perception of supervisors' responsible leadership and leader-member exchange. Besides, they also provided their demographic information. In this stage, we totally distributed 509 questionnaires and received 435 responses. One month later in time 2, the participants rated on their environmental consciousness, environmental apathy, and low-carbon behavior. In this stage, we distributed 435 questionnaires and finally received 417 responses. After removing the responses who took less than half the average time to complete the questionnaire, randomly selected one option, and selected wrong choice for attention check item, we got 411 valid data with a response rate of 80.75%. Among the valid samples, 54.30% were male, and 45.70% were female. The majority of participants were between 26 and 45 years old, accounting for 62.50%. In terms of education, 33.80% held an associate degree and 30.90% of the participants held a bachelor degree or above. The details are given in Table 1.

TABLE 1 Demographics analysis.

| Demographics | | Frequency | Percentage |
|---|---|---|---|
| Gender | Male | 223 | 54.30% |
| | Female | 188 | 45.70% |
| Age | 18–25 | 69 | 16.80% |
| | 26–35 | 118 | 28.70% |
| | 36–45 | 139 | 33.80% |
| | 46–55 | 68 | 16.50% |
| | over 56 | 17 | 4.10% |
| Education | Junior high school degree or below | 48 | 11.70% |
| | High school | 97 | 23.60% |
| | Associate degree | 139 | 33.80% |
| | Bachelor degree | 95 | 23.10% |
| | Master degree or above | 32 | 7.80% |

N = 411.

## Measures

Following the suggestion of Brislin (1980), we translated the scales from English version to Chinese version. All of the items we used in this study were assessed on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), unless mentioned otherwise.

## Responsible leadership

Responsible leadership is a form of leadership style, which requires leaders to be morally conscious toward the stakeholders inside and outside of the corporation, manifesting appropriate decision-making, trust building, sustainable development, and green action choices (Zhao and Zhou, 2019). A 5-item scale developed by Voegtlin (2011) was used to measure responsible leadership. The sample item is "My supervisor considers the consequences of decisions for the affected stakeholders," which was assessed on a scale from 1 = not at all to 7 = always (Cronbach's $\alpha = 0.870$).

## Environmental consciousness

Environmental consciousness refers to the degree to which individuals are concerned about environmental problems and are willing to make an effort to solve them (García et al., 2018). The participants reported their environmental consciousness using a 10-item scale from Alsmadi (2007). The sample item is "I get

TABLE 2 Confirmatory factor analysis.

| Model | $\chi^2$ | df | $\chi^2$/df | CFI | TLI | RMSEA | SRMR |
|---|---|---|---|---|---|---|---|
| Five-factor model: RL, EC, EA, LB, LMX | 787.607 | 730 | 1.079 | 0.994 | 0.994 | 0.014 | 0.043 |
| Four-factor model: RL+ LB, EC, EA, LMX | 1462.336 | 734 | 1.992 | 0.930 | 0.926 | 0.049 | 0.067 |
| Three-factor model: RL+ LB + EC, EA, LMX | 2924.083 | 737 | 3.968 | 0.790 | 0.777 | 0.085 | 0.096 |
| Two-factor model: RL+ LB + EC + EA, LMX | 4531.124 | 739 | 6.131 | 0.635 | 0.615 | 0.112 | 0.124 |
| One-factor model: RL+ LB + EC + EA + LMX | 6783.262 | 740 | 9.167 | 0.419 | 0.388 | 0.141 | 0.155 |

N = 411. RL = responsible leadership. EC = environmental consciousness. EA = environmental apathy. LB = low-carbon behavior. LMX = leader-member exchange. Same for the following tables.

annoyed when someone contaminates the environment." (Cronbach's α = 0.936).

## Environmental apathy

Environmental apathy means that individuals are carelessness toward the environmental protection, lack interest in environmental issues, and are inclined to consider the environmental problems have been exaggerated (Thompson and Barton, 1994; Gheith, 2013). The participants reported their environmental apathy using a 9-item scale from Thompson and Barton (1994). The sample item is "I do not care about environmental problems" (Cronbach's α = 0.920).

## Leader-member exchange (LMX)

LMX is a dyadic relationship that is built between a pair of supervisor and follower through a series of resources investment, and the high-quality of LMX relationship is characterized by mutual trust, respect, and liking (Bauer and Green, 1996; Liden and Maslyn, 1998; Zhang et al., 2020). We used a 7-item scale (Graen and Uhlbien, 1995) to measure employees' perceived LMX. The sample item is "I have enough confidence in my leader that I would defend and justify his/her decision if he/she were not present to do so" (Cronbach's α = 0.918).

## Low-carbon behavior

Low-carbon behavior refers to the behaviors that could impact the utility of substances or energy positively, and those would be able to change the structure and dynamics of an ecosystem positively (Li et al., 2020). The participants rated their low-carbon behavior with a 9-item scale from Bai and Liu (2013). The sample item is "I do not use disposable chopsticks" (Cronbach's α = 0.950).

## Control variables

Consistent with previous research (Xia et al., 2022), we controlled employees' demographic variables, including age, gender, and education levels.

# Results

## Confirmatory factor analysis

To test the discriminant validity of the constructs that were used in this study, we conducted a confirmatory factor analysis by using Mplus 8.1. As shown in Table 2, the five-model that consists of responsible leadership, environmental consciousness, environmental apathy, low-carbon behavior, and LMX shows the better fit indexes than other models ($\chi^2 = 787.607$, df = 730, $\chi^2$/df = 1.079, CFI = 0.994, TLI = 0.994, RMSEA = 0.014, SRMR = 0.043).

## Descriptive statistics

Table 3 shows the mean, standard deviations, and correlations of the variables. As expected, responsible leadership was positively related to employees' environmental consciousness ($r = 0.436$, $p < 0.01$), but negatively associated with employees' environmental apathy ($r = -0.234$, $p < 0.01$). Employees' environmental consciousness is positively associated with their low-carbon behavior ($r = 0.396$, $p < 0.01$), while employees' environmental apathy is negatively associated with their low-carbon behavior ($r = -0.283$, $p < 0.01$).

## Hypotheses testing

In this study, a structural equation model was conducted using maximum likelihood estimation along with 5,000 bootstrap estimations. The results in Table 4 have shown that responsible leadership has a positive impact on their subordinates' environmental consciousness ($\beta = 0.378$, $p < 0.001$), and has a negative impact on their environmental apathy ($\beta = -0.223$, $p < 0.001$). Hence, Hypotheses 1a and 2a were supported. In addition, employees' environmental consciousness positively influenced their reported low-carbon behavior ($\beta = 0.333$, $p < 0.001$), thus supporting Hypothesis 1b. Meanwhile, employees' environmental apathy negatively influenced their own low-carbon behavior ($\beta = -0.164$, $p < 0.01$), supporting Hypothesis 2b. The results also indicated that employees' environmental consciousness and environmental apathy both mediated the association between

TABLE 3 Means, standard deviations, and correlations.

| | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | 1.46 | 0.50 | - | | | | | | | |
| 2. Age | 2.63 | 1.07 | −0.034 | - | | | | | | |
| 3. Education | 2.92 | 1.14 | −0.055 | 0.003 | - | | | | | |
| 4. RL | 3.35 | 0.73 | −0.007 | −0.067 | −0.098* | **(0.870)** | | | | |
| 5. EC | 3.25 | 0.70 | −0.101* | −0.092 | 0.021 | 0.436** | **(0.936)** | | | |
| 6. EA | 2.66 | 0.69 | 0.028 | 0.012 | −0.038 | −0.234** | −0.352** | **(0.920)** | | |
| 7. LMX | 3.19 | 1.00 | 0.005 | −0.069 | −0.096 | 0.262** | 0.290** | −0.142** | **(0.918)** | |
| 8. LB | 3.28 | 0.68 | 0.000 | −0.033 | 0.004 | 0.447** | 0.396** | −0.283** | 0.243** | **(0.950)** |

N = 411. Internal consistent reliability (alpha) coefficients are shown along the diagonal in bold italics. Gender, 1 = male, 2 = female. Age, 1 = 18–25 years old, 2 = 26–35 years old, 3 = 36–45 years old, 4 = 46–55 years old, 5 = over 56 years old. Education level, 1 = junior high school degree or below, 2 = high school, 3 = associate degree, 4 = bachelor degree, 5 = master degree or above. ** $p < 0.01$, * $p < 0.05$. Same for the following tables.

TABLE 4 Regression results for directing and mediating effects.

| Predictor | Effect | S.E. | 95% CI | Significance |
|---|---|---|---|---|
| M1: Environmental consciousness | | | | |
| X: Responsible leadership | 0.378 | 0.046 | [0.286, 0.469] | < 0.001 |
| M2: Environmental apathy | | | | |
| X: Responsible leadership | −0.223 | 0.046 | [−0.312, −0.131] | < 0.001 |
| Y: Low-carbon behavior | | | | |
| M1: Environmental consciousness | 0.333 | 0.050 | [0.233, 0.427] | < 0.001 |
| M2: Environmental apathy | −0.164 | 0.050 | [−0.263, −0.066] | < 0.010 |
| Indirect effect of X on Y *via* M1 | | | | |
| M1: Environmental consciousness | 0.126 | 0.027 | [0.078, 0.184] | < 0.001 |
| Indirect effect of X on Y *via* M2 | | | | |
| M2: Environmental apathy | 0.036 | 0.015 | [0.012, 0.072] | < 0.050 |

N = 411. Effect = bootstrapped estimate. SE = standard error. LL = lower level. UL = upper level. CI = confidence interval. Same for the following tables.

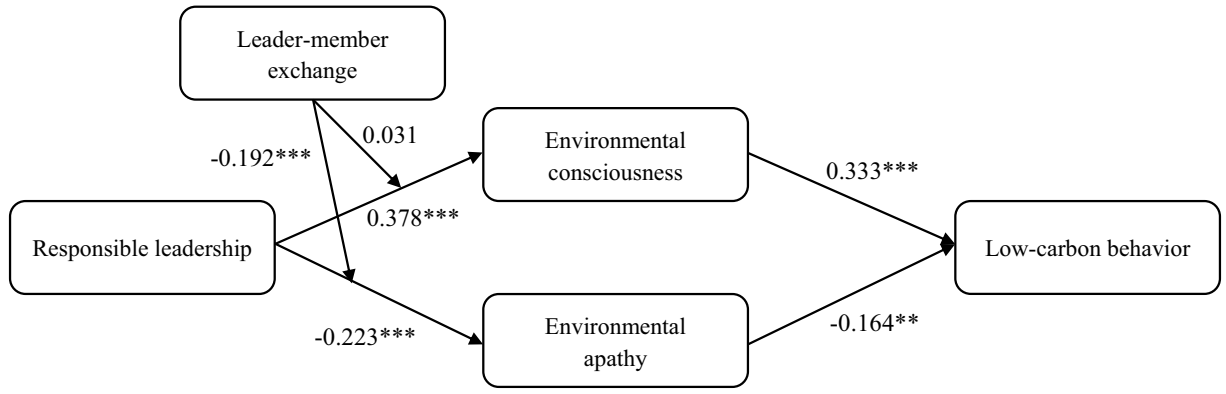


FIGURE 2
Unstandardized path coefficients from structural equation modeling results.

responsible leadership and employees' low-carbon behavior (Table 4). For environmental consciousness, the indirect effect is 0.126 (95% CI = [0.078, 0.184]); for environmental apathy, the indirect effect is 0.036 (95% CI = [0.012, 0.072]). Therefore, Hypotheses 1c and 2c were supported. In addition, Figure 2 presents the final model with the empirical results.

TABLE 5 Regression results for moderating effects.

| Predictor | Effect | S.E. | 95% CI | Significance |
|---|---|---|---|---|
| M1: Environmental consciousness | | | | |
| X: Responsible leadership | 0.378 | 0.046 | [0.286, 0.469] | < 0.001 |
| W: Leader-member exchange | 0.135 | 0.031 | [0.074, 0.194] | < 0.001 |
| Interaction: X × W | 0.031 | 0.042 | [−0.054, 0.112] | n.s. |
| M2: Environmental apathy | | | | |
| X: Responsible leadership | −0.223 | 0.046 | [−0.312, −0.131] | < 0.001 |
| W: Leader-member exchange | −0.058 | 0.034 | [−0.125, 0.008] | n.s. |
| Interaction: X × W | −0.192 | 0.044 | [−0.281, −0.105] | < 0.001 |

*N* = 411.

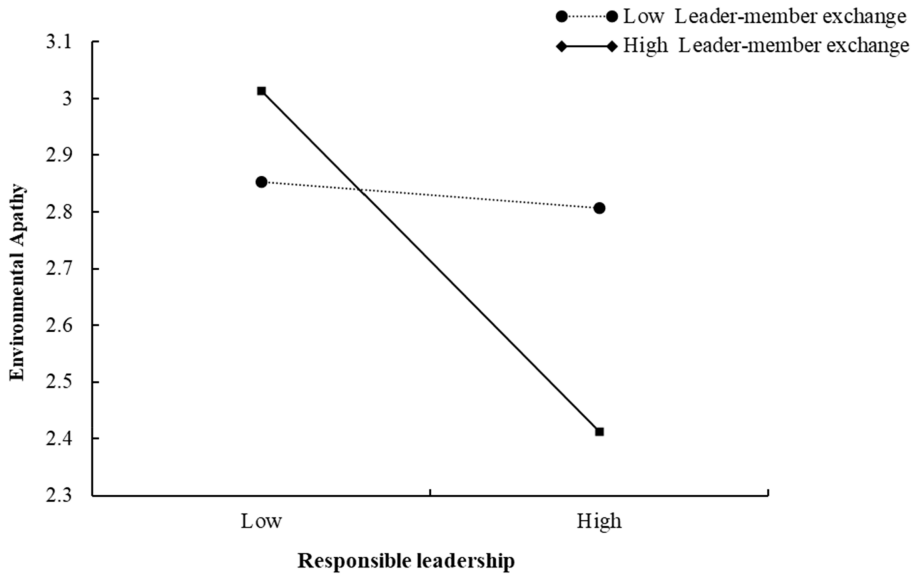


FIGURE 3
The moderating effect of LMX on the relationship between responsible leadership and employees' environmental apathy.

Moreover, we tested the moderating role of leader-member exchange. As shown in Table 5, the interaction effect between responsible leadership and LMX is positively related to employees' environmental apathy ($\beta = -0.192$, $p < 0.001$). But the influence of the interaction between responsible leadership and LMX on environmental consciousness is not significant ($\beta = 0.031$, $p > 0.05$). Figure 3 shows the simple slopes for different levels of LMX. In sum, Hypothesis 3b was supported, but Hypothesis 3a was not supported.

Furthermore, the empirical results in Table 6 confirmed that LMX moderated the indirect effect of responsible leadership on employees' low-carbon behavior *via* their environmental apathy. Specifically, the mediation influence of environmental apathy in the relationship between responsible leadership and employees' low-carbon behavior is stronger for employees who reported a higher level of LMX (i.e., conditional mediation effect = 0.068, 95% CI = [0.026, 0.123]) than those who reported a lower level of LMX (i.e., conditional mediation effect = 0.005, 95% CI = [−0.011, 0.032]), and the difference is also significant (difference = 0.063, 95% CI = [0.025, 0.115]). Hence, Hypothesis 4b was supported. However, although the mediation influence of environmental consciousness in the relationship between responsible leadership and employees' low-carbon behavior is stronger for employees with high-quality LMX (i.e., conditional mediation effect = 0.136, 95% CI = [0.082, 0.202]) than those with low-quality LMX (i.e., conditional mediation effect = 0.116, 95% CI = [0.061, 0.179]), the difference is not significant (i.e., difference = 0.021, 95% CI = [−0.037, 0.074]). Therefore, Hypothesis 4a was not supported.

## Discussion

Based on social cognitive theory, this study built a dual-mediation model and revealed the underlying mechanisms through

TABLE 6 Regression results for moderated mediating effects.

| Mediator | Leader-member Exchange | Effect | S.E. | 95% CI | Significance |
|---|---|---|---|---|---|
| M1: Environmental consciousness | −1 SD | 0.116 | 0.030 | [0.061, 0.179] | < 0.001 |
| | Equal to Mean | 0.126 | 0.027 | [0.078, 0.184] | < 0.001 |
| | +1 SD | 0.136 | 0.031 | [0.082, 0.202] | < 0.001 |
| | Difference | 0.021 | 0.028 | [−0.037, 0.074] | n.s. |
| M2: Environmental apathy | −1 SD | 0.005 | 0.010 | [−0.011, 0.032] | n.s. |
| | Equal to Mean | 0.036 | 0.015 | [0.012, 0.072] | < 0.050 |
| | +1 SD | 0.068 | 0.025 | [0.026, 0.123] | < 0.010 |
| | Difference | 0.063 | 0.023 | [0.025, 0.115] | < 0.010 |

N = 411. Values for quantitative moderators are the plus/minus one SD from mean.

which responsible leadership may impact employees' low-carbon behavior. The results demonstrated that responsible leadership was positively related to employees' environmental consciousness, but negatively related to employees' environmental apathy. Employees' environmental consciousness significantly promoted their low-carbon behavior, while employees' apathy was less likely to predict their low-carbon behavior. Besides, we also found the mediation effects of environmental consciousness and environmental apathy in the relationship between responsible leadership and low-carbon behavior. Furthermore, the results showed that LMX magnified the negative effect of responsible leadership on employees' environmental apathy, and the indirect effect of responsible leadership on employees' low-carbon behavior *via* environmental apathy. However, the moderating effects of LMX on the positive influence of responsible leadership on employees' environmental consciousness and on the indirect influence of responsible leadership on employees' low-carbon behavior *via* environmental consciousness were not supported. This result indicated that compared to employees' environmental consciousness, employees' environmental apathy may be more likely to be affected by the nature of LMX. That is, although employees with high LMX are inclined to follow the values of responsible leadership, they are more likely to show reduced environmental apathy, rather than increased environmental consciousness.

## Theoretical implications

Our study offers three theoretical contributions as follows. First, we contribute to the current literature by developing and testing a dual-mediation model to explore the influence of responsible leadership on employees' low-carbon behavior. The majority of previous research has investigated the impacts of responsible leadership on employees' work-related outcomes such as organizational commitment (Haque et al., 2019a), turnover intention (Haque et al., 2019b; Yasin et al., 2021), and job performance (Lin et al., 2020). However, as far as we know, to date, there is no study has focused on how responsible leadership affects employees' low-carbon behavior. In addition, exploring the antecedents of individuals' low-carbon behavior has important implications for building a low-carbon society and for achieving sustainable development. Therefore, we bridged this literature gap by building a conceptual model that could link responsible leadership to employees' low-carbon behavior from the perspective of social cognitive theory. Our study responds to the call of Waldman and Balven (2014) by increasing the knowledge of the consequence of responsible leadership. Overall, we enrich the literature on responsible leadership by revealing whether, how, and under which conditions responsible leadership may shape employees' non-work behaviors, enrich the literature on low-carbon behavior by shedding light on the important predicting role of responsible leadership, and finally expand the research scope of social cognitive theory into literature on responsible leadership and low-carbon behavior.

Second, this study revealed the underlying mechanism that could explain the influence of responsible leadership on employees' low-carbon behavior by testing the mediating effects of environmental consciousness and environmental apathy. Existing literature has demonstrated that individuals' environmental self-accountability (Xia et al., 2022), low-carbon knowledge (Lin and Yang, 2022), and carbon neutrality behavioral intention (Zhao et al., 2022) could positively predict their low-carbon behavior. However, relatively little research has explored whether responsible leadership may impact employees' low-carbon behavior and how this impact occurs. To address this gap, in this study, we identified environmental consciousness and environmental apathy as two potential paths that may link responsible leadership to employees' low-carbon behavior. The results showed that employees may internalize the values of responsible leadership by observing their effort in achieving sustainable development and green action choices (Zhao and Zhou, 2019). Influenced by leaders' responsible behavior in the organizations, employees may increase their environmental felt-responsibility and their concerns about ecological environment, thus boosting their environmental consciousness and reducing their environmental apathy (Han et al., 2019b; Afsar et al., 2020; Abbas et al., 2021). Further, motivated by their increased value on environmental protection, they may show more low-carbon

behavior in daily life (Casey and Scott, 2006; Huang et al., 2014). This study extends previous research by providing a reasonable explanation for why some employees show more low-carbon behavior and for how responsible leadership facilitate employees' eco-friendly behavior through changing their perceptions about environmental issues.

Third, after illustrating the mechanism of responsible leadership impacting employees' low-carbon behavior *via* environmental consciousness and environmental apathy, this study further answers the question of under which conditions responsible leadership may have the stronger or weaker effects on employees' cognitions and behaviors. In particular, we examined the moderating effect of LMX on the relationship between responsible leadership and employees' low-carbon behavior. The empirical results showed that compared with those employees with low LMX, employees with high LMX will tend to identify with their supervisors, be more likely to consider their supervisors as the role model, and be more willing to follow the environmental values of responsible leadership (Tse et al., 2012; Hu and Liden, 2013). Therefore, they may place a great value on environmental issues and show a lower level of environmental apathy than those employees who rated a low-quality of LMX. Furthermore, the mediation effect of environmental apathy in the relationship between responsible leadership and employees' low-carbon behavior was strengthened. However, the results did not support the moderating effects of LMX on the path of responsible leadership on low-carbon behavior *via* environmental consciousness, which showed that the interact effect of responsible leadership and LMX could exert a more salient influence on reducing employees' apathy than eliciting their consciousness toward the environment. Overall, in doing so, this study provides a more complete picture for understanding the effect of responsible leadership on employees' low-carbon behavior.

## Practical implications

Our study not only investigated the influence of responsible leadership on employees' low-carbon behavior through the dual-mediators of environmental consciousness and environmental apathy, but also provided some managerial suggestions for the organizations. First, this study found that responsible leadership could shape employees' low-carbon behavior by increasing employees' environmental consciousness and reducing their environmental apathy. This finding reinforced the necessary to focus on employees' attitudes and cognitions toward the environmental issues. This is in line with previous studies, which have pointed that some individuals are less likely to show pro-environmental behavior as they hold the anti-environmental attitudes (Abraham and Pane, 2016). Therefore, in the organizations, to achieve the sustainable development and maintain the harmony between people, society, and environment, leaders should act as a responsible role model for their subordinates. Besides, leaders also could put more effort into improving employees' environmental attitudes by sharing information about environmental problems, the urgency of environmental protection, and the significance of conducting low-carbon behavior.

Second, the finding that responsible leadership could significantly foster employees' low-carbon behavior also provides some suggestions for the organizations. Specifically, in order to achieve sustainable development, build a green society, achieve peak carbon dioxide emissions by 2030, and reach the goal of carbon neutrality by 2060, organizations should pay close attention on fostering managers' responsible leadership style. As leaders' behaviors have a vital influence on employees' behaviors and the organizations' development. Therefore, managers at all hierarchies should be encouraged to learn the government's requirements on the carbon emission, so as to reduce the organizations' carbon emission in daily production and meet the requirements of environmental protection. Moreover, organization could design some training programs for managers to enhance their environmental awareness, establish their low-carbon values and increase their abilities to guide employees' pro-environmental behaviors. Besides, the important characteristics that are embedded in responsible leadership could be used in selecting job hunters or promoting candidates.

Furthermore, this study indicated that high LMX can effectively magnify the negative effect of responsible leadership on employees' environmental apathy, and further the mediation effect of environmental apathy in the relationship between responsible leadership and employees' low-carbon behavior. This finding is consistent with previous studies, which showed that a higher level of LMX could exaggerate the effectiveness of leadership in improving employees' attitudes and behaviors (Michel and Tews, 2016; Niu et al., 2018). Besides, it also emphasized the importance of building high-quality exchange relationships with employees. Hence, to foster employees' low-carbon behavior, organizations could provide the opportunities for leaders and employees to increase their communications and cooperation such as arranging collective activities. And leaders should seek to build long-term working relationships with employees, endeavor to maintain the fairness when making decisions, and provide professional help or information for employees when they need, thus promoting employees' trust and respect toward them. In doing so, a high-quality of LMX could maximize the effectiveness of responsible leadership on elicit employees' eco-friendly behavior.

## Limitations and future research

Although this study has these above theoretical and practical implications, there still have some limitations. First, given that all the variables in our conceptual model were self-reported by employees, it may cause the concerns for common method bias. Thus, in order to test the detrimental influence of common method bias on our results, we conducted the Harman's single-factor analysis and confirmed that the problem of common method bias is acceptable in this study. Even so, we encourage future research to exclude the potential impact of common method bias from many aspects. For example, future studies could use the supervisor-subordinate dyadic design that is measuring responsible leadership by using the data

collected from supervisors or inviting other people who could observe employees' daily behaviors (i.e., supervisor, coworker, or family) to rate employees' low-carbon behavior.

Second, although we here examined the influence of responsible leadership on employees' low-carbon behavior, the studies on the non-work outcomes of responsible leadership still remain infancy. Thus, we invite future research to investigate how the effects of responsible leadership spill over outside of the working domain. Besides, based on social cognitive theory, this study revealed the underlying mechanism thorough which responsible leadership could mold employees' low-carbon behavior by identifying employees' environmental consciousness and environmental apathy as two mediators. Scholars could conduct more research in the future to examine the mediating effects of other variables in the relationship between responsible leadership and employees' low-carbon behavior. For example, future research could examine whether responsible leadership could promote employees' low-carbon behavior by influencing employees' CSR orientation or collectivist orientation.

Third, besides revealing the mediation mechanisms of responsible leadership impacting employees' low-carbon behavior, we also examined the boundary conditions that could alter the degree of the above mechanisms. That is, we confirmed that employees' perceived LMX not only positively moderated the direct effects of responsible leadership on employees' environmental apathy, but also moderated the indirect effect of responsible leadership on employees' low-carbon behavior *via* the above mediation. There have other boundary conditions that may influence the process of responsible leadership impacting employees. For example, future research could test the moderating effect of employees' power distance orientation or employees' leader identification on the relationship between responsible leadership and employees' low-carbon behavior.

## Conclusion

Based on social cognitive theory, we developed a dual-mediation model to examine the influence of responsible leadership on employees' low-carbon behavior. We found that responsible leadership could positively affect employees' low-carbon behavior by enhancing employees' environmental consciousness and reducing employees' environmental apathy, respectively. Moreover, we also found the moderating effects of LMX on the direct relationships between responsible leadership and employees' environmental apathy, and on the indirect relationship between responsible leadership and employees' low-carbon behavior *via* environmental apathy.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Author contributions

ZY and ZX contributed to the conception and design of the study. ZY organized the database. LX performed the statistical analysis. ZX wrote the first draft of the manuscript. ZY and LX wrote sections of the manuscript. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.1086504/full#supplementary-material

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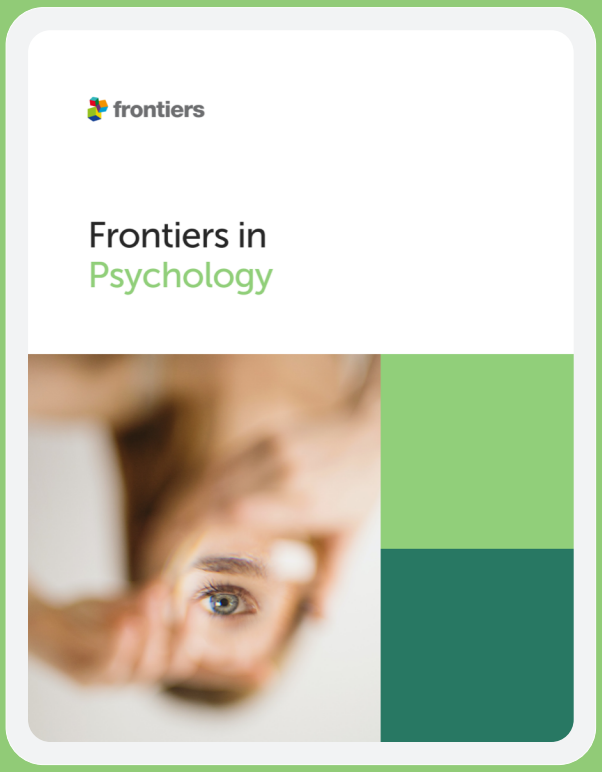


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