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Bosshard, A.; Berger, S.; Lange, F.; Sosa, A.; Kankaanpää, E.; Fellegi, E.; Dydula, J.; Pulicelli, M.; Aliyeva, O.; Brick, C.

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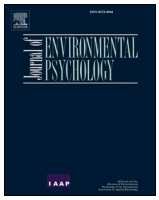

Limited overlap among behavioral tasks, pro-environmental propensity, and carbon footprint

Anna Bosshard [a,*], Sebastian Berger [b], Florian Lange [c], Andrea Sosa [a], Elisa Kankaanpää [a], Emma Fellegi [a], Julia Dydula [a], Michele Pulicelli [a], Ofelya Aliyeva [a], Cameron Brick [a,d]

[a] Department of Psychology, University of Amsterdam, the Netherlands
[b] Department of Sociology, University of Bern, Switzerland
[c] Behavioral Engineering Group, University of Leuven, Belgium
[d] Psychology, Inland Norway University of Applied Sciences, Elverum, Norway

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ABSTRACT

Self-reports of behavior are often aggregated to measure generalized pro-environmental propensity or environmental impact. Behavioral tasks such as the Carbon Emission Task (CET) and the Work for Environmental Protection Task (WEPT) allow observing specific behaviors with environmental consequences under controlled conditions. It is unclear to what extent these tasks reflect individual differences in pro-environmental propensity and environmental impact. In a pre-registered online study of 575 residents of England, we estimated associations between these behavioral tasks, common propensity and impact measures, as well as socioeconomic status. The CET and WEPT were weakly related to each other and weakly to moderately related to stronger environmentalist identity and the Recurring Pro-environmental Behavior Scale (REBS). This is consistent with the CET and WEPT covering part of people's generalized propensity to act pro-environmentally. In addition, the CET and REBS were weakly related to a lower carbon footprint, but the WEPT and environmentalist identity were not, providing further evidence that pro-environmental propensity has limited relevance for environmental impact. Income and wealth were moderately related to a higher carbon footprint, underscoring the need for changing high-impact behaviors, especially among affluent people.

1. Introduction

An accurate understanding of pro-environmental behavior is critical for sustainability (Nielsen et al., 2021a). Such understanding has proven difficult because researchers mean different things by pro-environmental behavior (Brick et al., 2022; Lange et al., 2023), such as impact (behavior that reduces environmental harms) or intent (behavior performed to reduce environmental harms) (Stern, 2000). Moreover, some researchers study concrete behaviors while others aggregate information across behaviors to study a person characteristic, i.e., a generalized propensity to behave pro-environmentally or cumulative environmental impact (Lange et al., 2023).

1.1. Pro-environmental propensity vs. environmental impact

Researchers interested in people's generalized pro-environmental propensity often use multi-item scales of the self-reported frequency of different behaviors, like recycling or signing petitions (Brick et al., 2017; Kaiser & Wilson, 2004). Items on these scales are selected to show high internal consistency, such that composite scores can be considered reflective measures of a latent person characteristic (i.e., pro-environmental propensity). Psychological variables like environmentalist identity are strongly linked to pro-environmental propensity (Huddart Kennedy et al., 2015; Moser & Kleinhückelkotten, 2018; Nielsen et al., 2021a, 2022).

This is fundamentally different from assessing the environmental impact of individuals (Moser & Kleinhückelkotten, 2018) summed from physical units like *kg* CO_2 emissions regardless of inter-item correlations (e.g., carbon footprint). Actual environmental impact depends not only on behavior but also on structural factors like energy grids, but impact-weighted assessments of behavior recognize that some individual actions are more consequential than others. Weak positive and sometimes even negative correlations have been reported between pro-environmental propensity and environmental impact (Bleys et al.,

* Corresponding author. Department of Psychology, University of Amsterdam, Nieuwe Achtergracht 129-B, 1018 WT, Amsterdam, the Netherlands.
E-mail address: a.bosshard@uva.nl (A. Bosshard).

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2018; Huddart Kennedy et al., 2015; Moser & Kleinhückelkotten, 2018; Nielsen et al., 2022), which has left confusion about which outcomes to use with which research questions (Gatersleben, 2023).

1.2. Consequential decision tasks

Self-reports are criticized for bias and noise (Koller et al., 2023; Kormos & Gifford, 2014; Nielsen et al., 2022) and overemphasizing correlational over experimental research (Lange & Dewitte, 2019; Lange et al., 2018). To facilitate the experimental study of pro-environmental behavior, researchers are developing consequential behavioral tasks, for instance, the Carbon Emission Task (CET) (Berger & Wyss, 2021b) and the Work for Environmental Protection Task (WEPT) (Lange & Dewitte, 2022) (review: Lange, 2023). These paradigms involve repeated trade-offs between behavioral costs and environmental consequences. In the CET, participants can decline financial gains to prevent carbon emissions (Berger & Wyss, 2021b), and in the WEPT, investing time and effort increases donations to a pro-environmental charity (Lange & Dewitte, 2022).

Experimental research manipulating the magnitude of these consequences over trials reveals that behavior causally depends on the behavioral costs and environmental consequences (Berger & Wyss, 2021b; Lange & Dewitte, 2023; Wyss et al., 2022). For example, in the CET, higher bonus payments decreased pro-environmental behavior and higher carbon emissions increased pro-environmental behavior (Berger & Wyss, 2021b). However, it remains unclear to what extent aggregated WEPT and CET behavior reflect individual differences in pro-environmental propensity and environmental impact. Pro-environmental propensity (as measured by the General Ecological Behavior scale) (Kaiser & Wilson, 2004) was positively related to the WEPT (Lange & Dewitte, 2021, 2022) and the CET (Hauser et al., in press), and the CET was negatively related to carbon footprint (Berger & Wyss, 2021b), but a simultaneous comparison is lacking.

Here, we estimate the relationships between the behavioral tasks, the Recurring Pro-environmental Behavior Scale (REBS) (Brick et al., 2017) as a behavior-based measure of pro-environmental propensity, and carbon footprint as a measure of environmental impact. We also included environmentalist identity as a belief-based measure closely related to pro-environmental propensity (Brick & Lai, 2018). We expected that the CET and WEPT would be positively associated due to variance around pro-environmental propensity (pre-registered Hypothesis 1). High correlations were not expected because we did not calibrate the costs of each task (i.e., make the effort in the WEPT and monetary cost in the CET equivalent). We expected the tasks to be associated more strongly with each other due to shared method variance (repeated trials on a computer screen) than either would be to the REBS (positively, pre-registered Hypothesis 2) or to carbon footprint (not pre-registered). Similarly, we expected that environmentalist identity would positively relate to the REBS and more strongly than to the behavioral tasks (positive) and to carbon footprint (negative) (pre-registered Hypothesis 3).

1.3. Socioeconomic status

Pro-environmental propensity and environmental impact may relate differently to demographics like income and wealth. People with high socioeconomic status had slightly stronger pro-environmental propensity (Grandin et al., 2022; Huddart Kennedy et al., 2015), but income and wealth related even more strongly to higher carbon footprint and household energy use (Huddart Kennedy et al., 2015; Moser & Kleinhückelkotten, 2018; Nielsen et al., 2021b, 2022). Therefore, including socioeconomic status could help disentangle the relationship between pro-environmental propensity, environmental impact, and the behavioral tasks. We expected higher income and wealth to be associated with a higher carbon footprint (pre-registered Hypothesis 4). Because behaving pro-environmentally on the CET and forgoing extra payment is easier for people with more resources (Berger & Wyss, 2021b), we expected higher income and wealth to be associated with more pro-environmental choices on the CET (pre-registered Hypothesis 4).

2. Methods

2.1. Open science statement and ethical approval

Materials, data, and code are available on the Open Science Framework (https://osf.io/9hy6z/?view_only=10936fe0f6e74464a2e7350a630b18d3). Our study was pre-registered (https://osf.io/vkcqs), and exploratory analyses are labeled. The study received ethical approval from The University of Amsterdam University of Amsterdam with protocol number 2021-COP-14178.

2.2. Measures

The survey included environmentalist identity, socioeconomic status, demographics, the CET and WEPT (randomized order), the REBS, carbon footprint, policy support, and perceived behavioral control in the CET (analyzed in a student thesis, see Supplement).

2.2.1. Environmentalist identity

Environmentalist identity was assessed using a four-item scale (Brick & Lai, 2018) with items rated from 1 (*strongly disagree*) to 7 (*strongly agree*). A sample item was: "I am pleased to be an environmentalist". Internal consistency was excellent (Cronbach's alpha = .92).

2.2.2. Socioeconomic status and demographics

Subjective social status was measured on the MacArthur social ladder (Operario et al., 2004) from 1 (*bottom*) to 10 (*top*). Education was measured as the highest level of school the participant had completed (U.K. system). Participants reported household income, household wealth, and we computed local household income (mean gross) based on postcodes (Supplement). When reporting their income, respondents indicated whether it was gross or net and monthly or yearly income, which we standardized to the yearly net income based on the U.K. tax brackets (Zwicker et al., 2023). Gender was measured by *male*, *female*, *other*, *prefer not to say*. Political orientation was measured on a scale from 1 (*extremely left wing*) to 7 (*extremely right wing*).

2.2.3. Carbon Emission Task (CET)

We used a variant of the validated CET (Berger & Wyss, 2021b). Across 20 trials, participants chose between receiving bonus payments and emitting carbon (*Option A*), or receiving nothing but avoiding carbon emissions (*Option B*). Fig. 1 shows an example CET trial. The trials fully crossed five bonus levels (20, 40, 60, 80, or 100 pence) and four associated carbon emissions (0.1, 0.46, 2.02, or 9.00 kg CO_2). Carbon emissions were also displayed in "car-miles driven" to facilitate comprehension. The proportion of pro-environmental choices across trials was calculated per participant, and one trial was randomly selected for bonus payment or emission retirement. The European Emission Trading System is a cap-and-trade system such that polluters must own emission certificates to emit carbon. Participants who chose the financial reward (with the associated emissions) received a bonus payment. When they opted against the bonus payment, we bought and retired an emission certificate, reducing the total available emissions in the trading system. Reliability sampling using 1.000 iterations indicated a Spearman-Brown corrected split-half reliability coefficient of .96, 95% CI [.95, .96] for mean scores (excellent) (Parsons, 2021).

2.2.4. Work for Environmental Protection Task (WEPT)

We used a variant of the validated WEPT (Lange & Dewitte, 2022). Participants were presented with an optional series of six pages of boring numerical tasks where they were asked to select only the numbers with even first and odd second digits. Fig. 2 shows an example page.

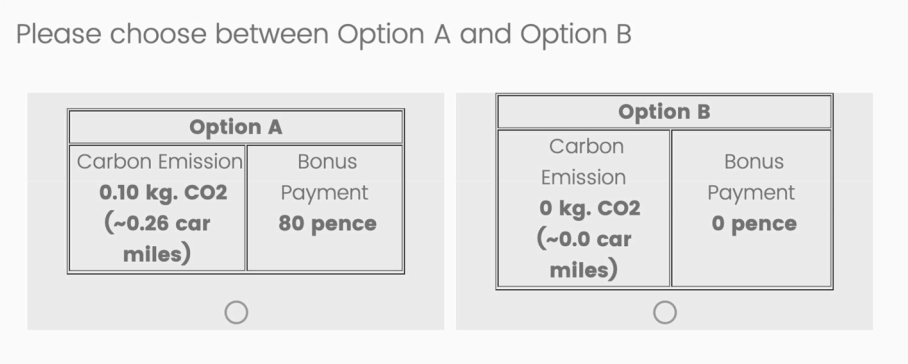

Fig. 1. Carbon emission task (CET) example page (1 of 20).

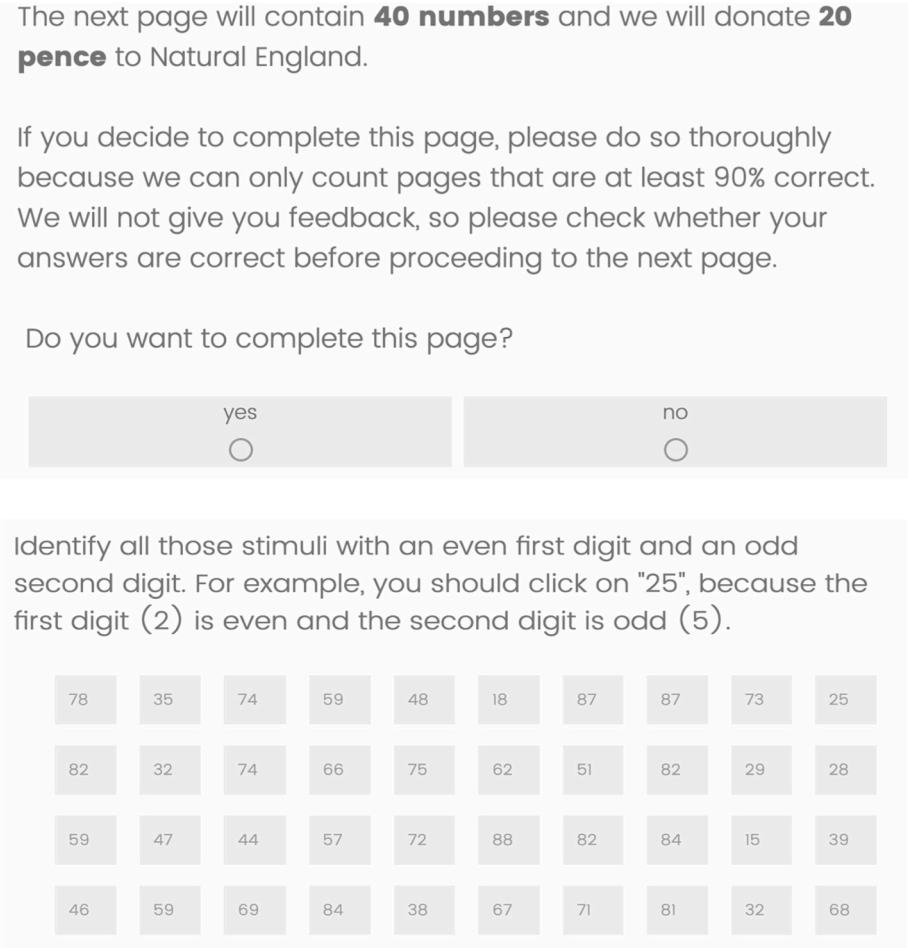

Fig. 2. Work for environmental protection task (WEPT) example (1 of 6).

Completing a page triggered a donation to the environmental charity *Natural England*. Task difficulty (40, 80, or 120 numbers per page) and environmental incentives (10 or 20 pence) were fully crossed. Pages were counted as completed if participants spent not less than 2 *SD* and a minimum of 10 *s* on that page, irrespective of accuracy. Reliability sampling using 1.000 iterations indicated a median Spearman-Brown corrected split-half parallel reliability coefficient of .87, 95% CI [.85, .89] (good) (Parsons, 2021).

2.2.5. Recurring Pro-Environmental Behavior Scale

Participants responded to the Recurring Pro-Environmental Behavior Scale (REBS) (Brick et al., 2017) consisting of 21 behavior frequencies including diet, transportation, and social interactions rated from 1 (*never*) to 5 (*always*). A sample item was: "How often do you eat meat?" (*reversed*). Internal consistency was acceptable (Cronbach's alpha = .74).

2.2.6. Carbon footprint

Participants completed a six-item version of a carbon footprint assessment (Berger & Wyss, 2021b) adopted from WWF Switzerland (n. d.). We selected items based on anticipated ease of responding and environmental impact (only carbon dioxide equivalents (CO_2e) above 1 *t*

per year), resulting in five domains: dairy and meat consumption, car travel, home size, and flying. Response options depended on the question, and a sample item was: "How large is your apartment or house in heated square meters without unfurnished garage, basement, or attic?". Rather than assigning equal weights to each item, all response options had CO_2e values, which we summed into composites adjusting car travel emissions based on the emissions factor of the reported fuel type (Table 1). Because the measure was calibrated in the Swiss context, it is only a proxy for the carbon footprint of residents of England.

2.2.7. Policy support

For exploratory analyses, we adapted a measure from the U.K. YouGov poll (Ibbetson, 2021) from which we selected the most impactful behaviors (mobility, diet, and heating) (Dubois et al., 2019), renewable energy, and corporate carbon taxes. Six items were rated from 1 (*strongly* support) to 5 (*strongly oppose*). A sample item was: "Limiting the amount of meat and dairy products people can buy per week". Internal consistency was acceptable (Cronbach's alpha = .75).

2.3. Participants and sample size

The sample consists of 575 residents of England who took part in an online survey through Prolific for 1.58 GBP and the opportunity to earn a bonus of up to 1.00 GBP in the CET (the recruitment text and exclusions are in the Supplement). Donations were made according to decisions in the WEPT, and emissions certificates were destroyed according to decisions in the CET. The sample was constrained in Prolific to have gender parity between men (49.2%) and women (48.5%) (Table 2).

The sample size was determined by exceeding the sample size at which correlations stabilize (i.e., 250) (Schönbrodt & Perugini, 2013), from the power needed to detect previously seen effect sizes, and budget constraints. A priori power analyses based on $n = 550$ are in the Supplement. Sensitivity analyses in the R package *pwr* revealed that $\alpha = .05$ and $n = 575$ yield 80% power to detect correlations of $r \geq .12$ and 95% power to detect correlations of $r \geq .15$.

3. Results

Fig. 3 is a heat map of Spearman's rank-order (r_s) correlations between key variables, controlling for whether the WEPT or CET was displayed first to account for potential order effects. The Supplement has descriptives, correlation coefficients, *p*-values, and 95% confidence intervals. Correlation strength was compared using *z* scores (Pearson & Filon, 1898) and bootstrapped confidence intervals (Zou, 2007) based on *r*-to-*z* transformation (Fisher, 1928).

3.1. Correlations between the CET, WEPT, REBS, and carbon footprint

First, we tested the relationships between the CET, WEPT, REBS, and carbon footprint. The CET and WEPT were weakly positively correlated, $r_s(574) = .16$, $p < .001$, 95% CI [.08, .24]. The CET was moderately positively correlated to the REBS, $r_s(570) = .29$, $p < .001$, [.21, .36] and this was stronger than the correlation between the CET and WEPT, difference $z = 2.55$, $p = .011$, [.03, .23]. The WEPT was weakly positively correlated to the REBS, $r_s(570) = .19$, $p < .001$, [.11, .27], which did not differ from the correlation between the CET and WEPT, difference $z = 0.62$, $p = .54$, [−.07, .13]. The CET was weakly negatively correlated to carbon footprint, $r_s(565) = -.13$, $p = .002$, [−.21, −.05], which did not differ from the correlation between the CET and WEPT, difference $z = -0.53$, $p = .60$, [-.14, .08]. The WEPT was not correlated with carbon footprint, $r_s(565) = .04$, $p = .343$, [-.04, .12]. In sum, supporting Hypothesis 1, the WEPT and CET were positively associated but their relationship was not stronger than the relationships between the tasks and the REBS and carbon footprint (for the CET), which opposed Hypothesis 2. The REBS was weakly negatively correlated to carbon footprint, $r_s(565) = -.09$, $p = .032$, [-.17, -.01]

Table 1
Carbon footprint domains and CO_2e.

Domain	Least CO_2e	Most CO_2e
Dairy consumption	Never (0.02 *t*)	More than four times daily (1.73 *t*)
Meat consumption	Never (0.03 *t*)	More than three times daily (1.45 *t*)
Annual distance by car	I never use a car or motorcycle (0 *t*)	More than 18,640 mi. (5.6 *t*)
Type of fuel car operates on	Electric (green) energy (annual distance (t) * −0.75)	Petrol/diesel/hybrid (annual distance (t) * 0)
Yearly number of hours flying	I did not fly in the last five years (0 *t*)	More than 50 h per year (13.48 *t*)
Size of apartment or house in m2	Smaller than 30 sqm (−0.7 *t*)	Bigger than 300 sqm (3.61 *t*)

Table 2
Demographics.

	M	SD	n	%
Age	39.9	15.4		
Gender				
Women			279	48.5
Men			283	49.2
Other			5	0.9
Missing			8	1.4
Education				
Primary school			5	0.9
Secondary school up to 16 years			57	9.9
Higher/secondary/further education			126	21.9
College or university			269	46.8
Post-graduate degree			111	19.3
Missing			7	1.2

Note. Gender was measured categorically (female, male, other, and "prefer not to specify").

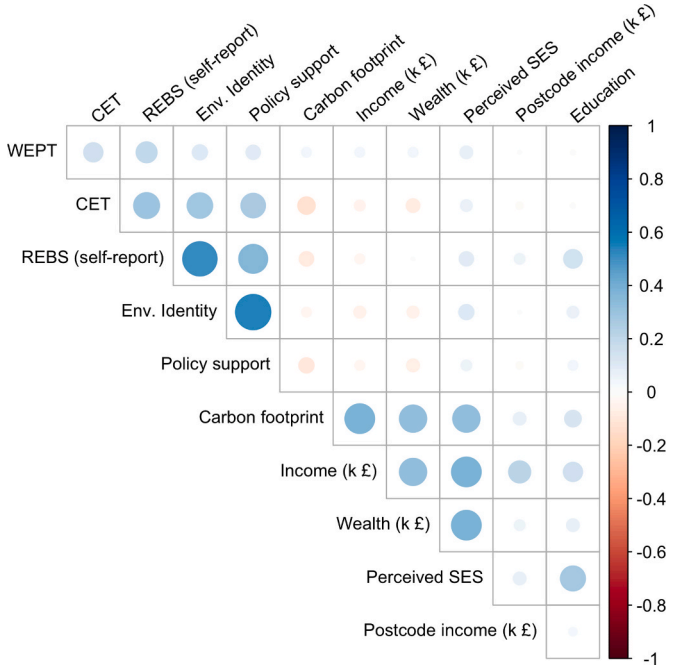

Fig. 3. Heatmap of Spearman's Correlations (τ_s) (Ns = 551–575).
Note. Larger circles represent stronger correlations and rs > |.08| are p < .05.

3.2. Correlations with environmentalist identity

Second, we tested how environmentalist identity related to the

behavioral tasks, the REBS, and carbon footprint. Identity was strongly positively correlated with the REBS, $r_s(570) = .51$, 95% CI [.45, .57], $p < .001$, weakly positively correlated with the CET, $r_s(570) = .28$, $p < .001$, [.20, .35], and weakly with the WEPT, $r_s(570) = .10$, $p = .017$, [.02, .18]. Identity was unrelated to carbon footprint, $r_s(565) = -.04$, [-.12, .04], $p = .343$. Identity was more related to the REBS than to the CET, difference $z = 5.25$, $p < .001$, [.14, .32], and to the WEPT, difference $z = 8.64$, $p < .001$, [.32, .50], supporting Hypothesis 3.

3.3. Correlations with socioeconomic status

Last, we tested how different measures of socioeconomic status related to the behavioral tasks, the REBS, and carbon footprint. Carbon footprint was moderately positively correlated with income, $r_s(563) = .38$, $p < .001$, 95% CI [.31, .45], and wealth, $r_s(555) = .32$, [.24, .39], $p < .001$. The CET was not correlated with income, $r_s(568) = -.05$, [-.13, .03], $p = .234$, or wealth, $r_s(558) = -.08$, [-.16, .00], $p = .059$. Hence, there was mixed support for Hypothesis 4 because socioeconomic status was associated with higher carbon footprint but not CET choices. The remaining measures of socioeconomic status (subjective social status, postcode income, education), the WEPT, REBS, and policy support were tested without directional hypotheses. Subjective social status was moderately positively associated with carbon footprint, $r_s(565) = .32$, [.24, .39], $p < .001$, education was weakly positively associated with carbon footprint, $r_s(561) = .12$, [.04, .20], $p < .01$, education was weakly positively associated with the REBS, $r_s(566) = .15$, [.07, .23], $p < .001$, and the remaining variables were uncorrelated.

4. Discussion

We estimated the associations between the CET and WEPT, the REBS, carbon footprint, environmentalist identity, and different measures of socioeconomic status. The results suggest that some variance in CET and WEPT choices is explained by pro-environmental propensity and that pro-environmental propensity has limited relevance for carbon footprint.

4.1. Implications for using the WEPT and CET

Pro-environmental choices in the CET and the WEPT were weakly associated. This is consistent with the view that individual differences in generalized pro-environmental propensity account for some variance in these tasks (Berger & Wyss, 2021b; Lange & Dewitte, 2021, 2022). The WEPT and CET also seem to involve a lot of task-specific variance: although relying on similar measurement contexts, they require different trade-offs for environmental protection (money vs. effort) and might tap into different ranges of cost. Stronger associations might be observed when increasing the similarity between the tasks, for instance, by linking WEPT efforts to the compensation of carbon emissions or by calibrating the respective costs and benefits (i.e., equating effort with monetary value). Previously, the CET was more closely related to belief in climate change and environmental attitudes when pro-environmental choices produced larger environmental benefits (Berger & Wyss, 2021a; Wyss et al., 2022). Following this logic, the tasks would relate more closely to pro-environmental propensity (and thus to each other) when their trade-offs become more relevant for people with a strong propensity. Simultaneously, very high environmental consequences or behavioral costs may result in similar behavior across people, regardless of pro-environmental propensity, similar to 'strong situations' in personality research (Mischel, 1977).

The positive association between the WEPT and CET could be due to motivations other than pro-environmental propensity or common-method variance. Yet, their positive associations with the REBS and environmentalist identity support the interpretation based on pro-environmental propensity. The WEPT was weakly positively associated with the REBS, and the CET was moderately positively associated with the REBS–the association between the CET and REBS being stronger than the association between the WEPT and CET. We had expected these associations to be weaker than the association between the WEPT and CET because the tasks would share more method variance. However, we overlooked that aggregating 21 self-report items allows abstracting from concrete behaviors and capturing propensity-related variance more reliably. In this respect, behavioral tasks focusing on one trade-off for environmental protection are more comparable to individual self-report items: they may indicate pro-environmental propensity but are not standalone measures (Lange & Dewitte, 2021). Supporting this conjecture, exploratory analyses revealed that the size of associations between the individual self-report items and the tasks were similar to the association between the tasks (Supplement).

Future research can help uncover what the WEPT and CET capture besides intending to protect or not harm the environment. For instance, variance in task behavior could be explained by personality traits like conscientiousness and openness (Brick & Lewis, 2016), social desirability, or situational factors like time pressure or experimentally induced preferences (Berger & Bregulla, 2023).

4.2. Implications for studying environmental impact

Our results align with the importance of socioeconomic status rather than pro-environmental propensity for environmental impact (Nielsen et al., 2021b; O'Neill et al., 2018; Wiedmann et al., 2020). The WEPT and environmentalist identity were unrelated to carbon footprint, and the REBS and CET related to a lower carbon footprint only weakly. Higher income, wealth, and subjective social status were moderately associated with a higher carbon footprint and unrelated to the behavioral tasks and the REBS. These results reinforce that targeting high-impact behavior, especially among affluent people, is critical for climate change mitigation (Creutzig et al., 2021). Addressing inequality in environmental policies is critical for reducing high-impact lifestyles (Büchs & Mattioli, 2022; Rammelt et al., 2023), and environmental psychologists can help understand and change behavior in these groups (Nielsen et al., 2021b; O'Neill et al., 2018; Wiedmann et al., 2020).

Of note, the carbon footprint measure we used relied on self-report, which is susceptible to social desirability and inaccuracy (Lange & Dewitte, 2019), and it had limited scope in terms of domains (diet, car travel, flying, and heating). Future research could use observational measures like behavioral traces (e.g., of energy use), life cycle assessments of other domains, or more comprehensive carbon footprint measures.

Exploratory analyses of the carbon footprint sub-domains align with the call for a behavior-specific understanding of environmental impact (Nielsen et al., 2021a). For instance, the REBS and the behavioral tasks related to lower meat consumption but not to flying (Supplement). Future research could also probe for non-linear relationships between pro-environmental propensity and carbon footprint. For example, among participants with the highest net incomes (>50,000 £), the negative association between the REBS and carbon footprint was slightly stronger (Supplement). We also note that the CET and carbon footprint moderately negatively correlated in a student sample (Berger & Wyss, 2021b). The weaker effect in the current study might be because students are more pro-environmentally motivated than the general public and not yet locked into carbon-intensive lifestyles.

5. Conclusion

Although the CET and WEPT overlapped somewhat with environmentalist identity and the REBS, we suggest these tasks should not be used in isolation as alternative measures for a generalized pro-environmental propensity (Deltomme et al., 2023; Lange & Dewitte, 2021). In addition, carbon footprint was better explained by socioeconomic status than by pro-environmental propensity, which underscores the importance of changing the most impactful behaviors irrespective of

their link to pro-environmental propensity.

CRediT authorship contribution statement

Anna Bosshard: Writing – review & editing, Writing – original draft, Visualization, Project administration, Investigation, Formal analysis. **Sebastian Berger:** Writing – original draft, Project administration, Methodology, Funding acquisition, Conceptualization, Writing – review & editing. **Florian Lange:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Andrea Sosa:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Elisa Kankaanpää:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Emma Fellegi:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Julia Dydula:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Michele Pulicelli:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Ofelya Aliyeva:** Formal analysis, Investigation, Methodology, Writing – review & editing. **Cameron Brick:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2024.102297.

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