Journal of Behavioral and Experimental Economics 119 (2025) 102474

Contents lists available at ScienceDirect

Journal of Behavioral and Experimental Economics

journal homepage: www.elsevier.com/locate/jbee

Environmental edutainment games and pro-environmental behavior of primary school students: Evidence from a field experiment

Emmanuel Dubois [a,#], Stefano Farolfi [b,e,#], Lisette Hafkamp-Ibanez [c,#], Sébastien Roussel [d,#,*]

[a] MSH-SUD, CNRS, University Montpellier Paul Valéry, University Montpellier, CIRAD, IRD, University Perpignan Via Domitia, Montpellier, France
[b] G-Eau, University Montpellier, CIRAD, INRAE, BRGM, IRD, AgroParisTech, Institut Agro, France.
[c] CEE-M, University Montpellier, CNRS, INRAE, Institut Agro, Montpellier, France
[d] CEE-M, University Montpellier, CNRS, INRAE, Institut Agro, University Montpellier Paul Valéry, Montpellier, France
[e] CEEPA, Univerity of Pretoria, South Africa

ARTICLE INFO

JEL classification:
C93
D90
I20
Q50

Keywords:
Behavioral economics
Behavioral interventions
Donation
Education
Edutainment
Environment
Lab-in-the-field experiment
Pro-environmental behavior

ABSTRACT

This study explores the effectiveness of behavioral interventions, specifically edutainment rooted in environmental education, in fostering pro-environmental behavior (PEB) among primary school students. Through a lab-in-the-field experiment, the research focuses on the impact of an environmental edutainment game on children's monetary donations to environmental non-governmental organizations (ENGOs) as PEB. Findings suggest that having played an environmental edutainment game does not significantly affect the amount donated, though it appears to influence the likelihood of making a donation, particularly among male and students from lower socio-economic backgrounds. Besides, female participants and students with a higher socio-economic and cultural profile exhibit higher likelihood to donate and higher effective donations, regardless of the edutainment intervention.

1. Introduction

Daily households' habits and decisions in consumption emerge as a primary contributor, comprising around 65 %, of the total global greenhouse gas emissions. This contribution is derived either directly from the utilization of fossil fuels or indirectly through the emissions embedded in the consumption of goods and services (Ivanova et al., 2020). As articulated by Williamson et al. (2018), the resolution of the global climate change crisis fundamentally hinges, in one form or another, upon the modification of human behavior. Diverse solutions, as outlined by the Intergovernmental Panel on Climate Change (IPCC, 2022), are available to trigger behavioral change. These solutions encompass initiatives to heighten environmental consciousness and advocate for pro-environmental behavior (PEB), that either avoid harming the environment (e.g., reducing single-use plastic consumption), minimize environmental impact (e.g., carpooling instead of driving alone), actively benefit the environment (e.g., planting native trees) (Steg and Vlek, 2009), or contribute to environmental non-governmental organizations (ENGOs) (Kollmuss and Agyeman, 2002).

Given that adults often have deeply ingrained habits and routines that are difficult to modify (Kurz et al., 2015), targeting interventions at children is essential. Children are more flexible and open to adopting new behaviors and represent the future generation that will need to address various growing environmental issues (Świątkowski et al., 2024). Children can influence their parents' behaviors through reverse socialization – a process whereby children's pro-environmental attitudes and behaviors positively shape those of adults (Singh et al., 2020;

* Corresponding author at: Université de Montpellier Paul Valéry. Route de Mende, 34199 Montpellier Cedex 5, France.
E-mail addresses: emml.dubois@gmail.com (E. Dubois), stefano.farolfi@cirad.fr (S. Farolfi), lisette.ibanez@inrae.fr (L. Hafkamp-Ibanez), sebastien.roussel@univ-montp3.fr (S. Roussel).
# These authors contributed equally to this work.

https://doi.org/10.1016/j.socec.2025.102474
Received 4 February 2025; Received in revised form 25 September 2025; Accepted 28 October 2025
Available online 29 October 2025

Wang and Li, 2024). Moreover, studying the decision-making in children and adolescents allow us to "understand the developmental causes of anomalous behavior in adults and to propose interventions at early stages to improve future outcomes" (Brocas and Carrillo, 2020a). For all these reasons, behavioral studies based on experimental methods on children and teenagers (Alfonso et al., 2023) have been implemented in the last twenty years in different domains, ranging from time preferences (Alan and Ertac, 2018; Bruhn et al., 2016; Lührmann et al., 2018) to risk preferences (Castillo et al., 2018; Eckel et al., 2012) to strategic behavior and social preferences (Brocas and Carrillo, 2020b, 2020c, 2021a, 2021b).

Several empirical studies have given interesting insights about environmental perceptions and preferences of children and teenagers. For instance, longitudinal research by Otto et al. (2019) discerns an inverted U-shaped growth curve in environmental attitude[1] and behavior development among children aged 7 to 18, indicating an increase until the age of 10, stability from 10 to 14, and a subsequent decline until 18. These authors suggest that, as in adulthood pro-environmental attitudes increase through the acquisition of more knowledge about environmental issues (Otto and Kaiser, 2014), it may be possible to alter the developmental trajectory for environmental behavior prior to its consolidation as a trait in early adulthood. This is in line with the positive impact of information provision dealing with environmental issues such as climate change (van Valkengoed et al., 2022), as the knowledge deficit model suggests that individuals are more likely to adopt pro-environmental behaviors when they possess adequate knowledge about environmental issues (Schultz, 2002). Supporting knowledge development to enhance pro-environmental behavior of children and teenagers is therefore important. Moreover, we might expect that, even if the effect is modest, children's environmental concern and knowledge will indirectly guide household practices by expressing preferences, making requests, or modeling behavior (Grønhøj and Thøgersen, 2009; Wang and Li, 2024). It will also be necessary to experimentally check how sustained over time are pro-environmental attitude changes discussed by Otto et al. (2019). Behavioral interventions, with a nexus to education, emerge as a salient avenue for enhancing PEB in children and young adults. A nexus between formal and/or informal education and environmental concerns, as well as PEB, has been empirically established in the existing literature through causal estimates in Europe and Asia (Meyer, 2015; Wang et al., 2022). Information provision as environmental knowledge transmission through nature-based environmental education, alongside connection to nature, emerges as pivotal drivers of individual ecological behavior (Kaiser et al., 2007; Otto and Pensini, 2017). Within the realms of environmental psychology, communication studies and economics, the efficacy of gamification as a means to foster awareness and knowledge for inducing behavioral change has been underscored (Lafortune et al., 2024; Ro et al., 2017). This is particularly pertinent concerning climate change, with board games proving instrumental in this regard and showing for participants increases of personal responsibility and of confidence in politics for climate change mitigation (Douglas and Brauer, 2021; Meya and Eisenack, 2018; Reckien and Eisenack, 2013). Reckien and Eisenack (2013) consider games as an alternative and a novel way of addressing climate change issues and communicating with decision-makers. Meya and Eisenack (2018) conclude that "simulation games can facilitate experiential learning about the difficulties of international climate politics and thereby complement both conventional communication and teaching methods". According to Douglas and Brauer (2021), "gamification can lead to longer-term psychological engagement than other behavior change methods such as nudging". The added value of employing educational games as edutainment to cultivate environmental awareness lies in their inherent enjoyment and capacity to simplify access to complex issues, thereby functioning as a social lever.

In a recently published systematic review about children's PEB, Liu and Green (2024) conclude that in this field "the experimental type studies primarily investigated the impact of intervention of environmental education, and yielded inconsistent outcomes". Consequently, and to contribute to this literature, in this paper we undertake an empirical inquiry into the efficacy of behavioral interventions through an educational game in promoting and enhancing PEB. Employing a lab-in-the-field experimental paradigm, our study enlists primary school students (aged between 7 and 12) as participants. The behavioral intervention consists in an environmental (nature-based) edutainment game designed to provide information and knowledge, specifically the *Nature Challenge* game (*Défis Nature*™).[2] A monetary donation to an environmental non-governmental organization (ENGO) is implemented as an observable metric for effective behavioral outcomes as PEB. Indeed, while the conceptual definition of PEB seems straightforward, the literature presents a multitude of measures used to assess PEB. These can be categorized into self-reported measures[3] and actual observed behaviors, either obtained through field or laboratory observations, in everyday life, or under experimental conditions (Lange and Dewitte, 2019). Świątkowski et al. (2024) found that the effectiveness of PEB assessment is substantially greater when PEBs are assessed with actual behavioral measures rather than self-reported ones. However, very few studies rely on these measures. In addition, implementing field measures like recycling or energy-saving behaviors often generates group-level data or influences behavior within a group, requiring interpretation at the group level. To observe individual decisions, researchers have used various games to simulate (environmental) decisions and track children's choices individually (Sutter et al., 2019). For example, Ebersbach et al. (2019) assessed children's sustainable behavior by observing their performance in a fishing conflict game (resource dilemma). As a consequence, we use in our study a monetary donation game as the dictator game which is a simple non-strategic game that is easy for children to understand and is often used to study social preferences in children and adolescents.

Our results show that while the edutainment intervention does not robustly affect the overall population, it significantly increases the likelihood of PEB adoption among males and students from lower socio-economic backgrounds. No significant effect is observed on the amount donated. Besides, female participants and students with a higher socio-economic and cultural profile exhibit higher likelihood to donate and higher effective donations, regardless of the edutainment intervention.

The limited significance of the observed effect in terms of PEB change suggests that a 'one shot' behavioral intervention in the shape of an environmental (nature-based) edutainment game is not sufficient to affect consistently children's environmental beliefs and behaviors. However, the specific effects on male students and students from lower socio-economic backgrounds indicate that repeating the experiences over the academic year could have positive effects, even beyond the affected subgroup.

The subsequent sections of this paper are organized as follows: Section 2 expounds upon the selected materials and methods, encompassing hypotheses, the experimental design and procedural framework; Section 3 presents the study's findings; and finally, Section 4 provides a comprehensive discussion and conclusive remarks.

[1] Note that we indifferently use the terms environmental attitude and environmental values in the remainder of the paper following Otto et al. (2019) and Aguilar-Luzón et al. (2020).

[2] For this study, we established a partnership with the non-profit activities / Foundation of the *Bioviva Editions* company. *Bioviva Editions* specializes in creating edutainment board and card games, predominantly centered around environmental themes.

[3] In the literature it is argued that self-reports estimates are only moderately correlated with actual behavior (Kormos and Gifford, 2014) which could be explained by the social desirability bias (Vesely and Klockner, 2020).

2. Materials and methods

2.1. Hypotheses

In this paper, we examine various behavioral hypotheses. Our initial hypothesis pertains to the positive impact of engaging in an environmental edutainment game, which provides information and increases knowledge, on the environmental donations of primary school students. This hypothesis finds support in the works by Meyer (2015); Otto and Pensini (2017); Sailer and Homner (2020); Suarez-Perales et al. (2021) and Wang et al. (2022), which established a causal relation between environmental education and PEB. Liu and Green (2024) indicate that the impact of environmental education is the most studied factor by experimental analyses. Additionally, Morganti et al. (2017) and Douglas and Brauer (2021) provide comprehensive reviews on gamification and its influence on consumers' PEB, showing that applied gaming has been used in different areas related to eliciting PEBs, including environmental education, consumption awareness, and energy efficiency behavior. Similarly, Boncu et al. (2022) show that serious games and apps were used to decrease energy consumption, water spending, and food consumption, and increase sustainable mobility. Furthermore, Meya & Eisenack, 2018 concentrate on the use of gaming to enhance awareness of climate change among students. Then, we hypothesize:

Hypothesis 1. *Engaging in an environmental edutainment game fosters pro-environmental behavior (PEB) in children.*

The next two hypotheses scrutinize influential factors associated with engaging in an environmental edutainment game. Firstly, we investigate the influence of participants' pre-existing environmental values on their PEB before playing the edutainment game. We posit that individuals with a heightened degree of environmental beliefs will be less susceptible to the impact of the edutainment game on their PEB. Even though the literature shows a positive correlation between personal interest in nature (affinity and emotional connectedness to the environment) and the intention to partake in PEB (Anderson and Krettenauer, 2021; Larson et al., 2011), we might expect a ceiling effect (Lange, 2023). Individuals with already strong pro-environmental attitudes may be less responsive and show lower marginal effects in response to behavioral interventions, as their behaviors are already aligned with their values, leaving little room for further improvement (Schultz, 2002; Thøgersen and Crompton, 2009). In contrast, individuals with moderate environmental concern might be more influenced by subtle behavioral prompts (Mertens et al., 2022; Whitmarsh, 2009). Hence, we hypothesize:

Hypothesis 2. *The impact of engaging in an environmental edutainment game on pro-environmental behavior (PEB) is influenced by children's baseline environmental values, with the strongest effects expected among those with moderate values, as children with already strong environmental attitudes may exhibit lower marginal responsiveness.*

Finally, our focus shifts to investigating the nexus between the socioeconomic status of primary school students and the impact of engaging in an environmental edutainment game on their PEB. In addition to the extensive research on the general correlation between the socioeconomic characteristics of participants and PEB (Blankenberg and Alhusen, 2019; Dlamini et al., 2022; Liu and Green, 2024), Grandin et al. (2022); Shen and Saijo, 2008 also found that higher socio-economic status correlates positively with a propensity for taking proactive environmental actions. Additionally, Runhaar et al. (2019) have identified an interplay between student characteristics and situational strengths, affecting PEB in Dutch secondary schools, while Mónus (2022) found that factors affecting students' PEB with the greater effect sizes were related to the socioeconomic background of students, i.e., socio-economic status of their schools, residency (settlement type and country region), and education of parents. Accordingly, our last hypothesis stands as follows:

Hypothesis 3. *Engaging in an environmental edutainment game fosters pro-environmental behavior (PEB) among children from higher socio-economic and cultural background.*

2.2. Experimental design

This study is a part of an extensive research protocol designed to investigate the impacts of environmental edutainment games. The complete protocol is structured into four distinct phases, as depicted in Fig. 1.[4]

The overall rationale of this protocol is outlined as follows. In Phase 1, attitudes, social representations, and knowledge related to nature are assessed fifteen days before the beginnings of the gaming sessions. Subsequently, in Phase 2, participants are engaged in playing an edutainment game, spread across four sessions within a two-day timeframe. Participants are divided into two distinct treatments (experimental, control). The experimental treatment involves playing an environmental edutainment game, while the control treatment entails playing a non-environmental edutainment game. Social interaction analysis during game sessions is conducted for select groups, utilizing video capture for detailed observation. In Phase 3, a re-evaluation of attitudes, social representations, and knowledge related to nature is conducted immediately after the conclusion of the final gaming session. This phase also incorporates the assessment of PEB. Finally, in Phase 4, occurring fifteen days subsequent to the third phase, another round of evaluation of attitudes, social representations, and knowledge related to nature takes place. This phase also includes a brief sociodemographic inquiry.

The primary focus of this paper is to measure the influence exerted by the environmental edutainment game, implemented during the second phase, as a behavioral intervention on the PEB observed in the third phase. Moreover, we analyze to what extent the impact of the environmental edutainment game on PEB is altered by environmental attitudes and sociodemographic variables such as gender or schools' social status.

The specific environmental edutainment game utilized for the experimental treatment is titled *Nature Challenge: Animal Records* (*Défis Nature™: Records des Animaux*). *Nature Challenge: Animal Records* is part of the *Nature Challenge* card game series, featuring over 50 variants. This particular game comprises 36 cards, each providing information and knowledge featuring an animal's name, image, and four key attributes: weight, size, life expectancy, and gestation/incubation period. Additionally, each card includes a brief text highlighting information on the animal's geographical location, history, its record and a color-coded chip indicating the species' extinction risk level. The game's objective in itself is to acquire other players' cards by selecting an attribute from the player's current card that surpasses the corresponding attributes on the opponents' cards. Players possessing cards with higher extinction risk levels can alter the contested attribute. The non-edutainment game

[4] The entire procedure was reviewed and received approval from the CEE-M Institutional Review Board (Univ. Montpellier – CNRS – INRAE – Institut Agro). The comprehensive ethical statement is as follows: "*The present project has been assessed according to the different articles of the CEE-M's Ethical Charter (approved by the CEE-M's scientific council), namely: dignity and integrity (A1), information and consent (A2), confidentiality and data protection (A3), storage and availability of the protocols and data (A4), scientific integrity (A5). Based on the referees' report, the Review Board considers that this project perfectly follows the rules established in the Ethical Charter.*" The research protocol was also reviewed and received endorsement from the French academic authorities, a mandatory step for conducting research within schools. Beyond these institutional approvals, a CNRS-compliant information note along with a consent form for children and parental authorization was distributed to the parents of participating children. The note succinctly outlines the research project, details on data collection and protection, and the rights of parents concerning data processing. The consent form required signatures from both the children and their legal guardians.

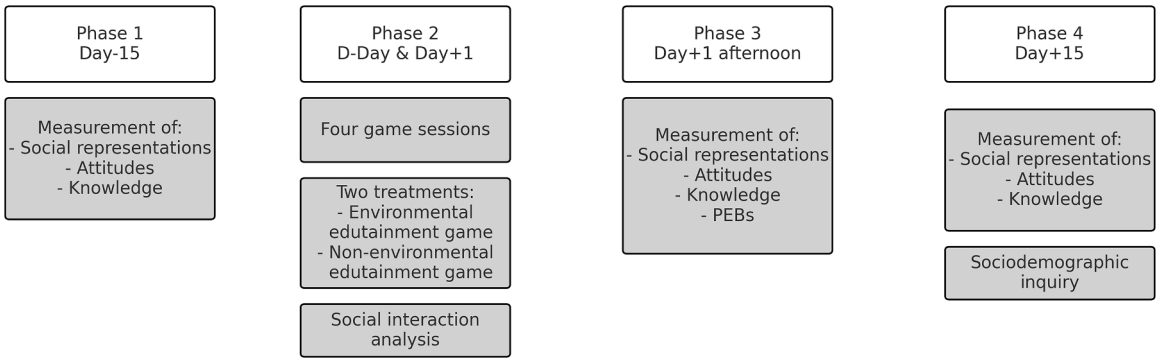

Fig. 1. Full project protocol.

employed for the control treatment is titled *Nature Challenge: Mythology, Heroes and Gods* (*Défis Nature: Mythologie, Héros et Dieux*). The game retains the same rules as its environmental counterpart, with features adapted to align with mythological characters and incorporating attributes such as wisdom.[5]

PEBs are measured using a child-adapted version of an environmentally themed monetary donation game. While the dictator game is traditionally used to measure general prosocial behavior, our version of the task was explicitly designed to capture PEB by directing donations toward an environmental NGO. This approach aligns with growing evidence that the framing and identity of the recipient significantly influence the motivational basis of donation decisions. For example, Klein et al. (2022) show that environmental framing elicits distinct psychological processes compared to social framing, activating environmental rather than purely altruistic motives. In addition, a meta-analysis by Umer et al. (2022) confirms that individuals tend to be more generous when donating to charitable NGOs, underscoring the importance of recipient identity in shaping behavioral responses. Our task builds on this literature by using a contextualized and environmentally framed version of the dictator game, in line with previous validated paradigms (e.g., Ibanez and Roussel, 2022; Lange, 2023; Lange and Dewitte, 2019), and is thus interpretable as a measure of pro-environmental orientation rather than general generosity. Consequently, this adaptation features a dictator game (Engel, 2011; Kahneman et al., 1986; List, 2007), wherein the donators are children (Benenson et al., 2007; Eckel et al., 2011; Harbaugh and Krause, 2000), and the recipient is an ENGO (Ibanez and Roussel, 2022; Ibanez et al., 2017; Klein et al., 2017). Children received 10 tokens, each valued at €5. They were given the choice to either purchase gifts for themselves or contribute to environmental causes (either planting trees or nurturing rescued young wild animals). To help children understand the value of their tokens, we used visual representations showing how each token could be used for either personal gifts or environmental donations.

Participants were asked to allocate tokens between their private account (for personal gifts) and an ENGO account (for environmental donations), choosing any integer between 0 and 10. The number of tokens in their private account determined their options for selecting gifts, ranging from less expensive to more expensive items on an age-appropriate and appealing list. Participants with more tokens in their private account could choose a single, more expensive gift, or select multiple less expensive items. Gifts were presented visually with images and names, although specific token values for each item were not disclosed.[6] To avoid any direct donation-induced effect from the experimental task featuring the cards, we asked participants to choose between two ENGOs: *PaysArbre*[7] and *Goupil Connexion*.[8] Each participant was given access to a description of ENGO to understand their respective activities. Tokens allocated to the chosen ENGO translated into measurable actions, such as the number of trees planted or the number of animals fed. Regarding the PEB decision, we implemented a random incentivized payment scheme.[9] Twenty percent of the participants from each school class were selected through a random process and effectively received the gifts and/or donated to the ENGOs. However, a small reward was granted to all participants in acknowledgment of their participation to the study and to avoid any sense of deception.

We also gathered a self-reported measure of children environmental attitudes using the Children's Environmental Perception Scale (CEPS) (Larson et al., 2011). This scale consists of sixteen items and evaluates two dimensions: eco-affinity and eco-awareness. The CEPS was chosen for its relevance to the nature, plant, and animal themes featured in the game *Nature Challenge: Animal Records*. The scale has been translated into French using a back-translation method involving two professional human translators.[10] The adapted French version employs a seven-point Likert scale for each item, ranging from one (Strongly disagree) to seven (Strongly agree), differing from the five-point scale used in the original version.[11]

[5] To maintain uniformity in gameplay across all participants, unique cards commonly included in each game box — cards that alter the game rules when played — were excluded from both editions of the game. These distinct cards exhibit variability from one game box to another, even within the same edition. Their exclusion was undertaken to eliminate potential discrepancies in gameplay, ensuring that all participants engaged in the game under identical conditions.

[6] The choice of gifts for the experiment, along with the decision not to assign them specific token values, was guided by insights from a pilot study, which also involved a debriefing session with the participants.

[7] *PaysArbre* is an NGO dedicated to forest protection – this NGO offers to use the donations for tree planting initiatives to preserve biodiversity, protect floors, and reduce air pollution.

[8] *Goupil Connexion* is an NGO dedicated to animal protection – this NGO offers to allocate the donations for nurturing rescued young wild animals.

[9] Clot et al. (2018) have shown that in an environmental donation game with adults, behavior is similar with a regular payment scheme and a randomized incentive scheme.

[10] Note that one item from the original scale has been removed from the French adaptation due to concerns over possible misinterpretation by the participants.

[11] The comprehensive research protocol aimed to evaluate attitude change through pre/post evaluations, and expanding the scale to seven points is intended to more precisely capture any potential changes in attitudes. In addition, five items have been modified in terms of grammatical tense, shifting from the present to the conditional, to better align with the study's focus on measuring changes in attitudes over a brief period.

Table 1
Definitions and descriptive statistics of the socio-demographic and attitudinal variables.

Variable	Description	Mean	Std Dev.	Min	Max
Age	Participant's age	9.62	1.15	7	12
Gender	Participant's gender				
Female	participant declares to be female,	0.42		0	1
Male	participant declares to be male,	0.46		0	1
Unwilling to respond	participant wishes not to reveal (no disclosure)	0.12		0	1
School grade	Level of education				
3rd grade	participant is in the 3rd grade,	0.42		0	1
4th grade	participant is in the 4th grade,	0.23		0	1
5th grade	participant is in the 5th grade	0.35		0	1
CEPS	Self-reported measure of children' environmental attitudes	5.50	0.99	1.40	7
SSI	School Social Status Index: Measure of the average socio-economic and cultural profile of students in each school	101.87	26.96	65.5	130.2

Note: $n = 226$. For the Age and Gender variables, descriptive statistics are provided for 203 observations as we have 23 missing data for the socio-demographic variables from participants who did not participate to Phase 4.

Furthermore, we consider a measure of social inequality through the School Social Status Index (SSI) (Dauphant et al., 2023), supplied by the French education system, based on the socio-economic status of the children's parents. This index serves as a quantitative measure of the average socio-economic and cultural profile of students in each school. Primary schools in France have SSI that ranges from 35.8 to 155.9.

Sociodemographic data (age, gender) were additionally collected to provide a comprehensive profile of the participants.

2.3. Participant pool and experimental procedure

2.3.1. Participant pool

The field experiment was carried out in seven primary schools situated in and around Montpellier, France. The sessions were conducted from April 2023 to June 2023. All experimental sessions were conducted during regular school hours, as part of the students' normal school day schedule. A total of 226 students from 12 school classes actively participated in the study.

Although full randomization was not feasible, efforts were made to approximate random assignment while minimizing selection bias. First, schools were selected through a stratified cluster randomization procedure based on their SSI, with the aim of ensuring a balanced representation. Subsequently, in five of the seven participating schools, a snowball-like procedure was implemented with regards to the difficulty of accessing children as a specific population: one teacher was initially contacted to present the study, framed as an environmental education intervention, and upon agreement, was asked to suggest a colleague. To preserve the integrity of the consent obtained under this framing, the initial teacher's class was systematically assigned to the experimental group, while the referred colleague's class was assigned to the control group. This approach ensured consistent treatment allocation across schools while maintaining a degree of randomness in participant selection. In the remaining two schools, only one class per school was recruited, with one class assigned to the experimental group and the other to the control group. To minimize contamination and the exchange of information between classes when two classes from the same school participated, we conducted the experiments on the same day and instructed both students and teachers to refrain from discussing the experiment until its completion.

Definitions and descriptive statistics of the socio-demographic variables are provided in Table 1. Participants' age ranges from 7 to 12, with a mean age of 9.62 years (SD = 1.5). Regarding gender, 42 % of participants identified as female, 46 % as male, and 12 % preferred not to disclose their gender. Notably, 23 participants did not participate in Phase 4; thus, we do not have any information on their age or gender. The school grade corresponds to the level of education with participants either in the 3rd (42 %), the 4th (23 %) or the 5th grade (35 %). Regarding the self-reported measure of participants' environmental attitudes (CEPS), we observe a high variability in scores, ranging from 1.4 to 7, with a mean value of 5.5 (SD = 0.99). Finally, the SSI provides the average socio-economic and cultural profile of students in each school that ranges between 65.5 and 130.2, with a mean value of 101.87 (SD = 26.86).

The twelve classes were evenly split between the control treatment and the experimental treatment. Out of the 226 participants, 116 participants were assigned to the control treatment (T1) and 110 to the experimental treatment (T2).

The objective of our study is to determine whether playing an environmental edutainment game reinforces PEB. Therefore, we must ensure that variables typically influencing PEB, such as gender, environmental attitudes or socio-economic and cultural background, are equally distributed across both treatments.

Table 2 indicates that the control and experimental treatments are equally balanced in terms of the main variables used in our statistical

Table 2
Balance table of the socio-demographic and attitudinal variables (between treatments) selected for statistical and econometric analyses.

Variable	Control treatment (T1)	Experimental treatment (T2)	Student's *t*-test *p*-value	Wilcoxon Ranksum (Mann-Whitney) test *p*-value
Gender = Female	0.42	0.42	0.971	0.971
	(0.5)	(0.5)		
School grade	2	1.86	0.242	0.227
	(0.86)	(0.89)		
CEPS	5.43	5.57	0.263	0.220
	(0.99)	(0.98)		
SSI	100.85	102.94	0.561	0.260
	(28.36)	(25.5)		

Notes: $n = 226$ for the whole sample split in 116 observations in T1 and 110 observations in T2. For the Gender variable, descriptive statistics are provided for 203 observations as we have 23 missing data for the socio-demographic variables from participants who did not participate to Phase 4.
Mean and Standard deviation in parentheses. Student's *t*-test on means and Wilcoxon Ranksum (Mann-Whitney) test on median values, respectively. *p*-value with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

analyses. Participants are identical in gender (T1: M_{Gender} (Female) = 0.42, SD = 0.5; T2: M_{Gender} (Female) = 0.42, SD = 0.5). We also do not find any statistical difference for the school grade (T1: $M_{School\ grade}$ = 2, SD = 0.86; T2: $M_{School\ grade}$= 1.86, SD = 0.89), the environmental values (T1: M_{CEPS}= 5.43, SD = 0.99; T2: M_{CEPS} = 5.57, SD = 0.98), and the social inequality measure (T1: M_{SSI}= 100.85, SD = 28.36; T2: M_{SSI} = 102.94, SD = 25.5).

For a more nuanced analysis, we constructed a binary variable that distinguishes participants with a lower level of environmental values (CEPS-Low) from those with a higher level of environmental values (CEPS-High), utilizing the classical median split at the 5.6-point threshold (Ibanez and Roussel, 2021). Similarly, given the importance of the socio-economic and cultural profile, we constructed a binary variable that categorizes participants attending a school with a low average level of socio-economic and cultural profile (SSI-Low) from those attending a school with a high average level (SSI-High), employing the median split at the 87.1-point limit.

2.3.2. Experimental procedure

Participants were instructed to form groups of three, and in cases where class sizes were not a multiple of three, a few groups of four were formed. These groups remained consistent across all four game sessions. Instructions were presented orally by one of the experimenters in three sets. A comprehensive set, containing all necessary information, was provided for the first game session. A summarized version, highlighting key elements, was used for the second game session, and a brief recap was delivered for the third and fourth game sessions.

Participants were allowed to communicate verbally within their groups but not between groups. Prior to gameplay, participants were given time to familiarize themselves with the cards: five minutes for the first game, three minutes for the second and third, and two minutes for the fourth. The duration of gameplay varied, with twenty minutes allocated for the first session and fifteen minutes for the subsequent ones.

At the conclusion of each game session, participants counted their cards to determine the winner at each table. The experimenter addressed any queries related to the rules and ensured adherence to the game's guidelines. Complete instructions to run the game are available in Supplementary Material S1 File.

The experiment was executed using the Qualtrics platform (Qualtrics, Provo, UT), with laptops provided in each classroom. Two wireless routers were employed to access Qualtrics, except in classrooms already equipped. Instructions were both displayed on screens and read aloud by the experimenters. Participants had the opportunity to seek clarifications by raising their hands, with individual clarifications provided unless a group clarification was deemed necessary. No new information was introduced during these clarification sessions.

The assessment of stated environmental attitudes occurred in Phases 1, 3, and 4, as outlined previously. In this paper, we consider only the data from the assessment of environmental attitudes in Phase 1. Indeed, even though engaging in environmental edutainment games may increase PEB through environmental awareness enhancement, as participants were split in two groups without the same experimental task at hand we rely on the initial assessment as an initial point for comparison. For the assessment, each statement from the Children's Environmental Perception Scale (CEPS) was presented on a separate page. The version of the scale adapted for this study is available in Supplementary Material S2 File. The class progressed through the statements at a consistent pace, with the experimenter reading each statement aloud, awaiting participant responses on the Likert scale before moving on to the next.

The Social Status Index (SSI) for each school was obtained from the *data.gouv.fr*[12] platform, which is the inter-ministerial portal designed to gather and freely provide access to all public information issued by the French government. In our sample, primary schools have SSI that ranges from 65.5 to 130.2 that allows us to avoid extreme values compared to the range at the French national level as stated in sub-Section 2.1 – from 35.8 to 155.

The procedure for measuring PEB was as follows (detailed instructions are available in Supplementary Material S3 File): participants were informed of their allocation of ten tokens, each valued at €5, and were tasked with deciding how to allocate them between personal retention (private account) and donation to an ENGO (ENGO account). They were briefed on the random draw process, using an example to illustrate the mechanism (in a class of twenty-five, five students would effectively receive gifts and/or make donations). Privacy of choices was guaranteed, with only the experimenters having access to the decisions. Information about post-experiment donations to ENGOs and detailed impacts of donations were provided. Participants then selected their preferred ENGO for potential donation and were shown available gifts, without specific token costs being disclosed. Finally, they allocated their tokens.

The selection process was conducted using a Bingo-style lottery machine. Selected participants privately chose gifts alongside an experimenter outside the classroom, who provided the list of gifts with corresponding token values. In Phase 4, selected participants received their gifts in sealed bags, along with a small reward for all participants. Experimenters consistently emphasized the importance of maintaining silence throughout the process.

The sociodemographic survey was completed by participants at the end of Phase 4 – this survey is available in Supplementary Material S4 File.

3. Results

3.1. Descriptive analysis

Fig. 2 displays the range of donations in our choice set by treatment (0–10 tokens).

Table 3 presents average donations and the share of participants who do not donate anything to the ENGO.[13]

On average, the amount given in tokens is slightly higher in the experimental treatment (3.43 tokens, SD = 3.08) compared to the control treatment (3.33 tokens, SD = 3.38). Additionally, the share of participants who did not donate anything is lower in the experimental treatment (19.09 %**) compared to the control treatment (31.90 %**). This result only partly supports Hypothesis 1, as engaging in an edutainment game does not significantly increase average donations but only increases significantly the probability of giving.

When considering the role of children's ecological attitude in the effectiveness of the edutainment game to increase donations, we observe that for children with higher CEPS scores, the experimental treatment shows a higher average donation (3.64 tokens, SD = 3.04) compared to the control treatment (3.29 tokens, SD = 3.49) though not statistically significant, with significantly fewer non-donors in the experimental treatment (17.54 %**) versus the control treatment (34.55 %**). We do not find any significant difference for children with lower CEPS scores. This finding suggests that the game has a more pronounced positive effect on children who initially possessed higher degrees of environmental values that is not in line with our Hypothesis 2.

[12] https://www.education.gouv.fr/indice-de-position-sociale-ips-actualisation-2022-377726

[13] It should be noted that the ENGO choices made by the participants were as follows: in the control treatment (T1), *PaysArbre* = 18% and *Goupil Connexion* = 82%; in the experimental treatment (T2), *PaysArbre* = 13% and *Goupil Connexion* = 87%. A chi-square test of independence indicates that the difference is not significant (p=0.439) with regards to the ENGO choices.

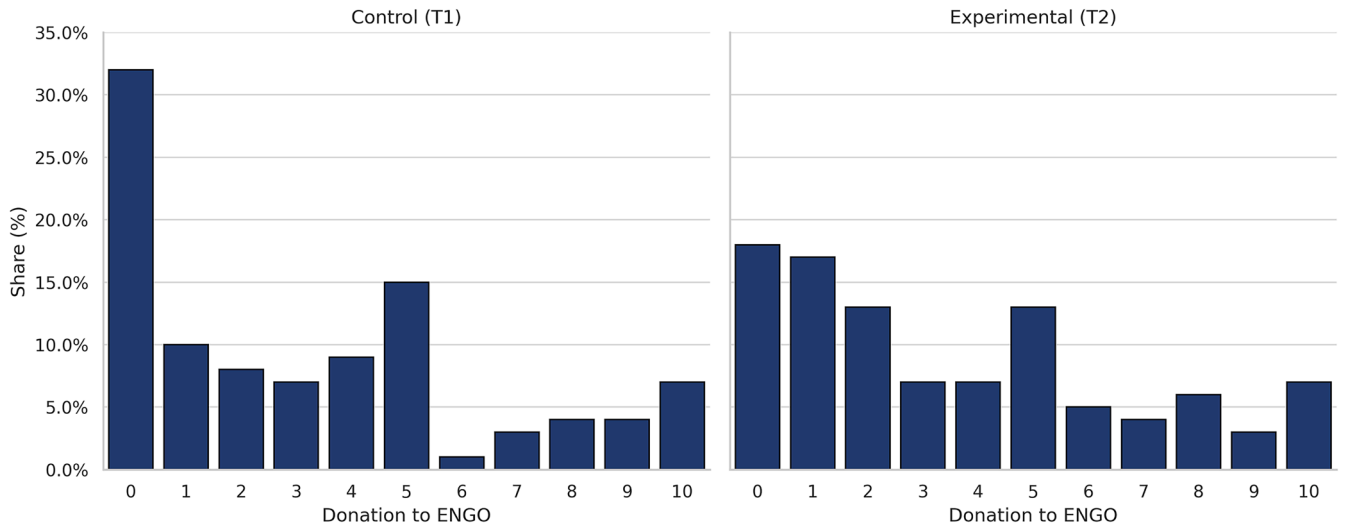

Fig 2. Range of donations (%) by treatment.

Table 3
Descriptive statistics on donations.

	Number of observations (*n*)	Average donations	Share of subjects who do not donate anything
Sample	226	3.38 (3.22)	25.66 % (43.77 %)
Of which			
Control treatment (T1)	116	3.33 (3.38)	31.90 %** (46.81 %)
Experimental treatment (T2)	110	3.43 (3.08)	19.09 %** (39.48 %)
CEPS-Low (Score $\leq$ 5.6)	114	3.28 (3.19)	25.44 % (43.74 %)
Of which			
Control treatment (T1)	61	3.36 (3.26)	29.51 % (45.99 %)
Experimental treatment (T2)	53	3.19 (3.14)	20.75 % (40.94 %)
CEPS-High (Score > 5.6)	112	3.47 (3.26)	25.89 % (44.01 %)
Of which			
Control treatment (T1)	55	3.29 (3.49)	34.55 %** (47.99 %)
Experimental treatment (T2)	57	3.65 (3.04)	17.54 %** (38.37 %)
SSI-Low (Score $\leq$ 87.1)	101	2.92 (3.06)	33.66 %** (47.49 %)
Of which			
Control treatment (T1)	51	2.49** (3.22)	49.02 %*** (50.49 %)
Experimental treatment (T2)	50	3.36** (2.85)	18 %*** (38.81 %)
SSI-High (Score > 87.1)	125	3.74 (3.31)	19.20 %** (39.55 %)
Of which			
Control treatment (T1)	65	3.98 (3.34)	18.46 % (39.10 %)
Experimental treatment (T2)	60	3.48 (3.29)	20 % (40.34 %)

Notes: Standard deviation in parentheses. Wilcoxon-Mann-Whitney equality-of-populations rank test with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We also observe that the impact of the game on PEB varied depending on the social context of participants. Among those participants attending schools with low SSI scores, the experimental treatment shows a significantly higher average donation (3.36** tokens, SD = 2.85) compared to the control treatment (2.49** tokens, SD = 3.22), with a notably lower proportion of non-donors in the experimental treatment (18 %***) versus the control treatment (49.02 %***). In contrast, for participants attending schools with high SSI scores, both the control and experimental treatments exhibit similar average donations (3.99 tokens, SD = 3.34 for the control treatment; 3.48 tokens, SD = 3.29 for the experimental treatment) and comparable percentages of non-donors (18.46 % for the control treatment; 20 % for the experimental treatment). This suggests that the game's effectiveness in fostering PEB is lower among children from higher socio-economic and cultural background, which contradicts Hypothesis 3. It is noteworthy that the proportion of non-donors was significantly higher in schools with low SSI scores (33.66 %) compared to those with high SSI scores (19.20 %).

3.2. Econometric analysis

To complete our descriptive analysis, we refine our results by means of econometric analyses. These analyses help in providing a more detailed understanding of the impact of the edutainment game on PEB, controlling for various factors and assessing the robustness of our findings. We use a Cragg–Hurdle regression model to comprehensively evaluate the impact of the *Nature Challenge: Animal Records* game on both the likelihood to donate (extensive margin of giving) and the amount donated (intensive margin of giving) (Altmann et al., 2019). This two-stage decision model combines a Probit model, explaining the factors influencing the donation decision (likelihood), and a linear regression on donations, conditional on being a donor (amount donated). In other words, this model disentangles the participation and quantity dimensions in the monetary donation process. Finally, we computed the marginal effects to address the effective monetary impacts, deriving conditional mean estimates from the significant explanatory variables used in both stages of the Cragg–Hurdle model (Williams, 2012). All econometric analyses were conducted using STATA software (16.0). Significance levels (1 %, 5 %, and 10 %) are indicated by ***, **, and *, respectively.

Table 4.1
Cragg–Hurdle estimates: donation decision (Likelihood) and donations (Amount).

Model# Regression model	(1) Cragg-Hurdle I: Likelihood		(2) Cragg-Hurdle I: Amount
Experimental treatment (T2)	0.404**		−1.118
	(0.183)		(0.839)
Control treatment (T1)	Ref.		Ref.
Constant	0.471***		3.760***
	(0.121)		(0.798)
sigma, constant		1.342***	
		(0.085)	
Observations	226		226
Cluster-robust standard errors	Yes		Yes

Notes: Dependent variable: donations (0 – 10). Robust standard errors in parentheses and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4.2
Cragg–Hurdle estimates: donation decision (Likelihood) and donations (Amount).

Model# Regression model	(3) Cragg-Hurdle II: Likelihood		(4) Cragg-Hurdle II: Amount	(5) Cragg-Hurdle III: Likelihood		(6) Cragg-Hurdle III: Amount
Experimental treatment (T2)	0.285		−1.301	0.309		−1.307
	(0.235)		(0.848)	(0.225)		(1.016)
Control treatment (T1)	Ref.		Ref.	Ref.		Ref.
Gender = Female, Yes				0.684***		−0.334
(versus others)				(0.182)		(0.970)
CEPS-High				−0.059		0.571
				(0.161)		(0.696)
SSI-High				0.459**		0.264
				(0.225)		(1.184)
Constant	0.522***		3.486***	0.033		3.209**
	(0.183)		(0.839)	(0.152)		(1.505)
sigma, constant		1.365***			1.360***	
		(0.089)			(0.096)	
Observations	203		203	203		203
Cluster-robust standard errors	Yes		Yes	Yes		Yes

Notes: Dependent variable: donations (0 – 10). Robust standard errors in parentheses and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Effective impacts (Tokens) in terms of conditional mean estimates (average marginal effect): 0.772* for Gender in the Cragg-Hurdle III model.

In the first regression model (Cragg-Hurdle I; Table 4.1), we observe that playing the *Nature Challenge: Animal Records* game positively influences the likelihood to donate (0.404**). Next, we introduce additional covariates related to socio-economic and cultural profile and environmental attitudes, while also incorporating gender as a conventional feature of prosocial behavior. As we have 23 missing data for the socio-demographic variables, of which gender-related information, from participants who did not participate to Phase 4, our sample is then reduced to 203 observations. Consequently, in running again the analysis without and with these covariates on those observations, this significant positive treatment effect disappears leading to null results (Cragg-Hurdle II and Cragg-Hurdle III; Table 4.2) questioning the robustness and sensitivity of our initial results.[14] Besides, our results show that female participants and those with a high level of SSI exhibit increased probabilities of donating (0.684*** and 0.459**, respectively) (Cragg-Hurdle III; Table 4.2). In addition, adding a female participant would increase the number of tokens donated worth 0.772 token on average (marginal effect). In light of these results and in order to further our analysis, we incorporate interaction terms in a fourth regression model (Cragg-Hurdle IV; Table 4.3), which allows us to obtain more detailed and specific results. Indeed, overall playing the *Nature Challenge: Animal Records* game now and again significantly increases the likelihood of making a donation (0.963***), consistent with our initial findings (Table 4.1). Gender and SSI-High variables still act positively on the probability of giving as female participants and those with a high level of SSI are more likely to donate (1.032*** and 1.049***), and both variables would increase the number of tokens donated worth 0.772 token and 0.889 token on average (marginal effects), respectively. More importantly, the positive impact of playing the *Nature Challenge: Animal Records* game is specific to male participants and participants with a low SSI profile. For female participants, the positive effect of the edutainment game is mitigated (T2 x Gender = −0.628**). Similarly, for children with a high socio-economic and cultural profile, the game's impact is lessened (T2 x SSI-High = −1.125**). In other words, male participants and those with a low SSI profile are those who benefit from engaging in our edutainment game dedicated to nature. In none of the models do we observe any significant effect of playing the edutainment game on the amount donated.

In conclusion, our econometric analysis on donations provides only partial support for Hypothesis 1. While we find evidence that the intervention increases the likelihood to donate to an ENGO, this effect is not consistently robust across specifications, and no significant impact is detected on average donations. Hypothesis 2, which posited a positive impact of environmental values on PEB among those with moderate values, is not supported by our findings. Similarly, Hypothesis 3, which posited that edutainment interventions focused on nature would enhance PEB among children from higher socio-economic and cultural backgrounds, is not supported by our findings either. Instead, the

[14] In the full sample ($N = 226$), the intervention yields a statistically significant effect, suggesting that the treatment has a detectable behavioral impact. When restricting the analysis to the reduced sample ($N = 203$), the effect remains similar in magnitude and direction (signs in both regressions), though loses statistical significance. This sensitivity reflects the expected reduction in statistical power due to the smaller sample size and wider confidence intervals, rather than a substantive change in the underlying effect.

Table 4.3
Cragg–Hurdle estimates: donation decision (Likelihood) and donations (Amount).

Model#	(7)	(8)
Regression model	Cragg-Hurdle IV: Likelihood	Cragg-Hurdle IV: Amount
Experimental treatment (T2)	0.963***	−2.435
	(0.323)	(2.264)
Control treatment (T1)	Ref.	Ref.
Gender = Female, Yes	1.032***	−1.311
(versus others)	(0.251)	(1.037)
CEPS-High	−0.245	0.237
	(0.249)	(0.851)
SSI-High	1.049***	0.297
	(0.211)	(2.161)
T2 x Gender	−0.628**	1.999
	(0.276)	(1.719)
T2 x CEPS-High	0.344	0.472
	(0.318)	(1.531)
T2 x SSI-High	−1.125***	−0.082
	(0.381)	(2.461)
Constant	−0.318**	3.863*
	(0.156)	(2.091)
sigma, constant	1.351***	
	(0.097)	
Observations	203	203
Cluster-robust standard errors	Yes	Yes

Notes: Dependent variable: donations (0 – 10). Robust standard errors in parentheses and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Effective impacts (Tokens) in terms of conditional mean estimates (average marginal effect): 0.762* for Gender and 0.869** for SSI-High in the Cragg-Hurdle IV model.

intervention appears to be more effective among children with a lower school-based socio-economic and cultural profile.

4. Discussion and conclusion

This paper delves into an investigation of the potential of edutainment games to induce pro-environmental behavior (PEB) among young children. A lab-in-the-field experiment was conducted with primary school students to assess the impact of multiple sessions of an edutainment game as an information provision and knowledge enhancing mean on the financial contributions of 7 to 12-year-old students towards an environmental non-governmental organization (ENGO). Results indicate a limited and not entirely conclusive effect of participation in the *Nature Challenge: Animal Records* game on the likelihood of charitable giving. This effect appears to be particularly pronounced among male children and children with lower socio-economic and cultural backgrounds (as measured by the Social Status Index (SSI)), that shows a significant higher probability of donating after having played the edutainment game, which is in line with results obtained by Caserta et al. (2025). No substantial evidence supports the notion that edutainment games lead to an increase in the monetary amounts donated by participants.

The scope of our results must be reflected in terms of (*ex post*) power analysis. Considering both our sample size and the differences in average donations between treatments results in a low statistical power of 7.88 %. This low power prevents us from conclusively determining whether the Nature Challenge: Animal Records game has no effect on donation amounts or if the effect is simply too small to detect (G*Power 3.1.9.2; Faul et al., 2007). However, by excluding non-donors and focusing solely on average positive donations from participants who actually donate in both treatments, we achieve an *ex post* statistical power of 41 %. More critically, through a deeper analysis of the act of giving—aligned with our findings on the increased likelihood of donating due to engagement in an environmental edutainment game—we attain an *ex post* statistical power of 66 %. This illustrates the potential impact of our results on behavioral change.

Our findings, although limited in scope relative to the hypotheses formulated, can be interpreted in light of information provision. The intervention provided children with contextualized and emotionally engaging information about local biodiversity, highlighting habitats, threats, and ecological roles of real animal species. This type of information provision, especially when embedded in interactive and narrative formats, has been shown to enhance environmental awareness and support for climate action (van Valkengoed et al., 2022). By grounding abstract environmental challenges in concrete, relatable scenarios, the game may have helped translate concern into pro-environmental intentions. Moreover, the limited significance of the observed effect on PEB suggests that a one-time behavioral intervention, in the form of a nature-based edutainment game, is insufficient to consistently influence children's environmental beliefs and behaviors. However, the specific positive effects observed among male students and children with lower socio-economic backgrounds suggest that repeated exposure to such experiences over the course of the academic year could yield more robust and widespread outcomes. The observed effect on students with lower socio-economic background may be due to the limited availability of environmental discourse in their home or neighborhood contexts. In these environments, such games can effectively foster nature connectedness and convey environmental knowledge, potentially outperforming or complementing traditional environmental education methods (Pensini et al., 2016). To enhance PEB, it is therefore crucial to disseminate and implement such interventions especially in less advantaged schools and poorer areas. Regular engagement with these interactive activities may offer additional opportunities for peer-to-peer exchange, in-class discussion facilitated by teachers, and reflection once students return home, thereby reinforcing the intended environmental messages through multiple channels of influence. Nonetheless, the implementation of repeated edutainment-based interventions in primary schools must account for time and resource constraints. The integration of such activities into already crowded curricula, along with the logistical and financial costs involved, represents a significant limitation for scaling and sustaining these experiences. Future research and policy design should therefore weigh the potential educational benefits of repeated exposure against these practical barriers, and explore cost-effective ways to embed environmental learning more systematically into everyday school life.

Our research presents several limitations and calls for further investigations. The first limitation relates to the external validity of our results. To ensure that our findings are generalizable to a broader context, other measurements of PEB should be tested to capture the effect of the behavioral intervention on a wider range of children's environmental behaviors. Enhanced and diverse measurement tools will provide a more comprehensive understanding of how children engage with and contribute to environmental conservation, thereby strengthening the external validity of our research. The external validity is also questioned if the edutainment game is played outside the school environment (at home, with friends, holiday camps, etc.). The second limitation pertains to the validity of our observational measure, specifically regarding the underlying motivation for giving in an environmental donation game. Although donation levels in the control treatment are similar to adult behavior (Ibanez and Roussel, 2022; Ibanez et al., 2017), we are not able to assert that children possess cognitive and non-cognitive skills comparable to adults when considering environmental associations as recipients. Additional research is finally necessary to understand the long-term effects of the behavioral intervention. In our experimental protocol, children participated in the environmental edutainment game four consecutive times, followed immediately by the environmental donation game. It would be valuable to investigate whether the impact of the behavioral intervention could be enhanced through regular and sustained engagement. Furthermore, exploring the durability of PEB over time is essential to ascertain the lasting effectiveness of such interventions.

Last, one may stress that in this paper we focus on the behavioral dynamics of young children, a population of particular relevance for

several reasons. First, encouraging environmentally responsible behavior in youth constitutes a strategic long-term investment, as early-life experiences have been shown to shape later-life outcomes (List et al., 2023). In particular, identity-based preferences developed during childhood – such as environmental values or habits – can influence future decisions, especially in domains involving ethical or normative concerns (Akerlof and Kranton, 2000; Bénabou and Tirole, 2011). As emphasized by Brocas and Carrillo, 2020b, 2020c), studying decision-making in children is essential for understanding the developmental roots of adult behavior and for designing age-appropriate interventions. Interventions that are tailored to children's cognitive and emotional development stages – such as edutainment games – can enhance both learning and engagement. In this sense, even modest attitude changes at an early age may act as precursors to broader, sustained behavioral transformations over the life course. Second, reverse socialization effects have been increasingly documented: children's pro-environmental knowledge and attitudes can influence the behavior of their parents, siblings, and peers (Grønhøj and Thøgersen, 2009; Singh et al., 2020; Wang and Li, 2024). Through preference expression and environmentally motivated requests, children may thus play a subtle yet significant role in shaping household practices. These spillover dynamics reinforce the idea that behavioral interventions targeting children can have a multilevel impact beyond the individual level (Charry and Parguel, 2019).

CRediT authorship contribution statement

Emmanuel Dubois: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Stefano Farolfi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Lisette Hafkamp-Ibanez:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sébastien Roussel:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2025.102474.

Data availability

I've shared my data at the previous stage in an Excel file

References

Aguilar-Luzón, M. C., Carmona, B., Calvo-Salguero, A., & Castillo Valdivieso, P. A. (2020). Values, environmental beliefs, and connection with nature as predictive factors of the pro-environmental vote in Spain. *Frontiers in Psychology, 11*, 1043.

Akerlof, G. A., & Kranton, R. E. (2000). Economics and identity. *The Quarterly Journal of Economics, 115*(3), 715–753.

Alan, S., & Ertac, S. (2018). Fostering patience in the classroom: Results from randomized educational intervention. *Journal of Political Economy, 126*, 1865–1911.

Alfonso, A., Brañas-Garza, P., Jorrat, D., Lomas, P., Prissé, B., Vasco, M., & Vázquez-De Francisco, M. J. (2023). The adventure of running experiments with teenagers. *The Journal of Behavioral and Experimental Economics, 106*, Article 102048.

Altmann, S., Falk, A., Heidhues, P., Jayaraman, R., & Teirlinck, M. (2019). Defaults and donations: Evidence from a field experiment. *The Review of Economics and Statistics, 101*(5), 808–826.

Anderson, D. J., & Krettenauer, T. (2021). Connectedness to nature and pro-environmental behaviour from early adolescence to adulthood: A comparison of urban and rural Canada. *Sustainability, 13*, 3655.

Bénabou, R., & Tirole, J. (2011). Identity, morals, and taboos: Beliefs as assets. *Quarterly Journal of Economics, 126*(2), 805–855.

Benenson, J. F., Pascoe, J., & Radmore, N. (2007). Children's altruistic behavior in the dictator game. *Evolution and Human Behavior, 28*, 168–175.

Blankenberg, A.-K., & Alhusen, H. (2019). *On the determinants of pro-environmental behavior: A literature review and guide for the empirical economist*. Göttingen: University of Göttingen, Center for European, Governance and Economic Development Research (Cege). Cege Discussion Papers. 350.

Boncu, Ş., Candel, O.-S., & Popa, N. L. (2022). Gameful Green: A systematic review on the use of serious computer games and gamified mobile apps to foster pro-environmental information, attitudes and behaviors. *Sustainability, 14*(16), Article 10400.

Brocas, I., & Carrillo, J. D. (2020a). Introduction to special issue "understanding cognition and decision making by children." Studying decision-making in children: Challenges and opportunities. *The Journal of Economic Behavior and Organization, 179*, 777–783.

Brocas, I., & Carrillo, J. D. (2020b). The development of social strategic ignorance and other regarding behavior from childhood to adulthood. *The Journal of Behavioral and Experimental Economics, 85*, Article 101524.

Brocas, I., & Carrillo, J. D. (2020c). The evolution of choice and learning in the two-person beauty contest game from kindergarten to adulthood. *Games and Economic Behavior, 120*, 132–143.

Brocas, I., & Carrillo, J. D. (2021a). Self-serving, altruistic and spiteful lying in the schoolyard. *The Journal of Economic Behavior and Organization, 187*, 159–175.

Brocas, I., & Carrillo, J. D. (2021b). Steps of reasoning in children and adolescents. *Journal of Political Economy, 129*, 2067–2111.

Bruhn, M., de Souza Leao, L., Legovini, A., Marchetti, R., & Zia, B. (2016). The impact of high school financial education: Evidence from a large-scale evaluation in Brazil. *American Economic Journal: Applied Economics, 8*(4), 256–295.

Caserta, M., Distefano, R., Ferrante, L., & Reito, F. (2025). Challenging the free-rider: Children behavior in a public goods game. *The Journal of Behavioral and Experimental Economics, 117*, Article 102400.

Castillo, M., Jordan, J. L., & Petrie, R. (2018). Children's rationality, risk attitudes and field behavior. *European Economic Review, 102*, 62–81.

Charry, K., & Parguel, B. (2019). Educating children to environmental behaviours with nudges: The effectiveness of social labelling and moderating role of age. *Environmental Education Research, 25*(10), 1495–1509.

Clot, S., Grolleau, G., & Ibanez, L. (2018). Shall we pay all? An experimental test of random incentivized systems. *The Journal of Behavioral and Experimental Economics, 73*, 93–98.

Dauphant, F., Evain, F., Guillerm, M., Simon, C., & Rocher, T. (2023). L'indice de position sociale (IPS): Un outil statistique pour décrire les inégalités sociales entre établissements. Note d'Information. *Direction De L'Evaluation, De La Prospective Et De La Performance (DEPP), 23*(16).

Dlamini, S., Tesfamichael, S. G., & Mokhele, T. (2022). A selective review of environmental perceptions, attitudes, place attachment, and their spatial characterisation: Contrasting the South African and global perspectives. *Environmental Review, 30*(4), 552–562.

Douglas, B. D., & Brauer, M. (2021). Gamification to prevent climate change: A review of games and apps for sustainability. *Current Opinion in Psychology, 42*, 89–94.

Ebersbach, M., Malkus, D., & Ernst, A. (2019). Factors that affect primary school children's sustainable behavior in a resource dilemma. *The Journal of Experimental Child Psychology, 184*, 18–33.

Eckel, C. C., Grossman, P. J., Johnson, C. A., de Oliveira, A. C. M., Rojas, C., & Wilson, R. (2011). Social norms of sharing in high school: Teen giving in the dictator game. *The Journal of Economic Behavior and Organization, 80*, 603–612.

Eckel, C. C., Grossman, P. J., Johnson, C. A., De Oliveira, A. C. M., Rojas, C., & Wilson, R. K. (2012). School environment and risk preferences: Experimental evidence. *Journal of Risk and Uncertainty, 45*(3), 265–292.

Engel, C. (2011). Dictator games: A meta study. *Experimental Economics, 14*, 583–610.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.

Grandin, A., Guillou, L., Sater, R. A., Foucault, M., & Chevallier, C. (2022). Socioeconomic status, time preferences and pro-environmentalism. *The Journal of Environmental Psychology, 79*, Article 101720.

Grønhøj, A., & Thøgersen, J. (2009). Like father, like son? Intergenerational transmission of values, attitudes, and behaviours in the environmental domain. *The Journal of Environmental Psychology, 294*, 414–421.

Harbaugh, W. T., & Krause, K. (2000). Children's altruism in public good and dictator experiments. *Economic Inquiry, 38*, 95–109.

Ibanez, L., & Roussel, S. (2021). The effects of induced emotions on environmental preferences and behavior: An experimental study. *PLoS ONE, 16*(9), Article e0258045.

Ibanez, L., & Roussel, S. (2022). The impact of nature video exposure on pro-environmental behavior: An experimental investigation. *PLoS ONE, 17*(11), Article e0275806.

Ibanez, L., Moureau, N., & Roussel, S. (2017). How do incidental emotions impact pro-environmental behavior? Evidence from the dictator game. *The Journal of Behavioral and Experimental Economics, 66*, 150–155.

IPCC.,Summary for policymakers [Shukla PR et al. (ed(2022).s.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA.

Ivanova, D., Barrett, J., Wiedenhofer, D., Macura, B., Callaghan, M., & Creutzig, F. (2020). Quantifying the potential for climate change mitigation of consumption options. *Environmental Research Letters, 15*, Article 093001.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1986). Fairness and the assumptions of economics. *The Journal of Business, 59*(4), S285–S300.

Kaiser, F. G., Oerke, B., & Bogner, F. X. (2007). Behavior-based environmental attitude: Development of an instrument for adolescents. *The Journal of Environmental Psychology, 27*(3), 242–251.
Klein, S. A., Hilbig, B. E., & Heck, D. W. (2017). Which is the greater good? A social dilemma paradigm disentangling environmentalism and cooperation. *The Journal of Environmental Psychology, 53*, 40–49.
Klein, S. A., Horsten, L. K., & Hilbig, B. E. (2022). The effect of environmental versus social framing on pro-environmental behavior. *The Journal of Environmental Psychology, 84*, Article 101897.
Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*(3), 239–260.
Kormos, C., & Gifford, R. (2014). The validity of self-report measures of proenvironmental behavior: A meta-analytic review. *The Journal of Environmental Psychology, 40*, 359–371.
Kurz, T., Gardner, B., Verplanken, B., & Abraham, C. (2015). Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. *WIREs Climate Change, 6*(1), 113–128.
Lafortune, J., Pugatch, T., Tessada, J., & Ubfal, D. (2024). Can gamified online training make high school students more entrepreneurial? Experimental evidence from Rwanda. *Economics of Education Review, 101*, Article 102559.
Lange, F. (2023). Behavioral paradigms for studying pro-environmental behavior: A systematic review. *Behavior Research Methods, 55*, 600–622.
Lange, F., & Dewitte, S. (2019). Measuring pro-environmental behavior: Review and recommendations. *The Journal of Environmental Psychology, 63*, 92–100.
Larson, L. R., Green, G. T., & Castleberry, S. B. (2011). Construction and validation of an instrument to measure environmental orientations in a diverse group of children. *Environment and Behavior, 43*, 72–89.
List, J. A. (2007). On the interpretation of giving in dictator games. *Journal of Political Economy, 115*(3), 482–493.
List, J. A., Petrie, R., & Samek, A. (2023). How experiments with children inform economics. *Journal of Economic Literature, 61*(2), 504-564.
Liu, Y., & Green, K. C. (2024). Children's pro-environmental behaviour: A systematic review of the literature. *Resources, Conservation and Recycling, 205*, Article 107524.
Lührmann, M., Serra-Garcia, M., & Winter, J. (2018). The impact of financial education on adolescents' intertemporal choices. *American Economic Journal: Economic Policy, 10*, 309–332.
Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. *PNAS, 1191*, Article e2107346118.
Meya, J. N., & Eisenack, K. (2018). Effectiveness of gaming for communicating and teaching climate change. *Climate Change, 149*, 319–333.
Meya, J. N., & Eisenack, K. (2018). Effectiveness of gaming for communicating and teaching climate change,. *Climatic Change, Springer,, 149*(3), 319–333.
Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics, 116*, 108–121.
Mónus, F. (2022). Environmental education policy of schools and socioeconomic background affect environmental attitudes and pro-environmental behavior of secondary school students. *Environmental Education Research, 28*(2), 169–196.
Morganti, L., Pallavicinia, F., Cadela, E., Candelierib, A., Archettib, F., & Mantovani, F. (2017). Gaming for Earth: Serious games and gamification to engage consumers in pro-environmental behaviours for energy efficiency. *Energy Research & Social Science, 29*, 95–102.
Otto, S., & Kaiser, F. G. (2014). Ecological behavior across the lifespan: Why environmentalism increases as people grow older. *The Journal of Environmental Psychology, 40*, 331–338.
Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change, 47*, 88–94.
Otto, S., Evans, G. W., Moon, M. J., & Kaiser, F. G. (2019). The development of children's environmental attitude and behavior. *Global Environmental Change, 58*, Article 101947.
Pensini, P., Horn, E., & Caltabiano, N. J. (2016). An exploration of the relationships between adults' childhood and current nature exposure and their mental well-being. *Children, Youth and Environments, 26*, 125–147.
Reckien, D., & Eisenack, K. (2013). Climate change gaming on board and screen: A review. *Simulation & Gaming, 44*(2–3), 253–271.
Ro, M., Brauer, M., Kuntz, K., Shukla, R., & Bensch, I. (2017). Making cool choices for sustainability: Testing the effectiveness of a game-based approach to promoting pro-environmental behaviors. *The Journal of Environmental Psychology, 53*, 20–30.
Runhaar, P., Wagenaar, K., & Runhaar, H. (2019). Encouraging students' pro-environmental behaviour: Examining the interplay between student characteristics and the situational strength of schools. *The Journal of Education for Sustainable Development, 13*, 1.
Sailer, M., & Hommer, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review, 32*, 77–112.
Schultz, P. W. (2002). Knowledge, information, and household recycling: Examining the knowledge-deficit model of behavior change. In T. Dietz, & P. C. Stern (Eds.), *New tools for environmental protection: Education, information, and voluntary measures* (pp. 67–82). National Academy Press.
Shen, J., & Saijo, T. (2008). Reexamining the relations between socio-demographic characteristics and individual environmental concern: Evidence from Shanghai data. *The Journal of Environmental Psychology, 28*(1), 42–50.
Singh, J., Zhang, Y., & Scribner, L. L. (2020). Pro-environmental behavior in families: A reverse socialization perspective. *Journal of Business Research, 116*, 660–670.
Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *The Journal of Environmental Psychology, 29*(3), 309–317.
Suárez-Perales, I., Valero-Gil, J., Leyva-de la Hi, D. I., Rivera-Torres, P., & Garcés-Ayerbe, C. (2021). Educating for the future: How higher education in environmental management affects pro-environmental behaviour. *Journal of Cleaner Production, 321*, Article 128972.
Sutter, M., Zoller, C., & Glätzle-Rützler, D. (2019). Economic behavior of children and adolescents – a first survey of experimental economics results. *European Economic Review, 111*, 98–121.
Świątkowski, W., Surret, F. L., Henry, J., Buchs, C., Visintin, E. P., & Butera, F. (2024). Interventions promoting pro-environmental behaviors in children: A meta-analysis and a research agenda. *The Journal of Environmental Psychology, 96*, Article 102295.
Umer, H., Kurozaki, T., & Iwasaki, I. (2022). Unearned endowment and charity recipient lead to higher donations: A meta-analysis of the dictator game lab experiments. *The Journal of Behavioral and Experimental Economics, 97*, Article 101827.
Thøgersen, J., & Crompton, T. (2009). Simple and painless? The limitations of spillover in environmental campaigning. *Journal of Consumer Policy, 32*, 141–163.
van Valkengoed, A. M., Abrahamse, W., & Steg, L. (2022). To select effective interventions for pro-environmental behaviour change, we need to consider determinants of behaviour. *Nature Human Behaviour, 6*, 1482–1492.
Vesely, S., & Klöckner, C. A. (2020). Social desirability in environmental psychology research: Three meta-analyses. *Frontiers in Psychology, 11*, 1395.
Wang, Q., & Li, C. (2024). The mechanism of adolescent environmental passion influencing parent pro-environmental behavior: Evidence from China. *The Journal of Environmental Psychology, 89*, Article 102342.
Wang, Q., Niu, G., Gan, X., & Cai, Q. (2022). Green returns to education: Does education affect pro-environmental attitudes and behaviors in China? *PLoS ONE, 17*(2), Article e0263383.
Whitmarsh, L. (2009). Behavioural responses to climate change: Asymmetry of intentions and impacts. *The Journal of Environmental Psychology, 291*, 13–23.
Williams, R. (2012). Using the margins command to estimate and interpret adjusted predictions and marginal effects. *Stata Journal, 12*(2), 308–331.
Williamson, K., Satre-Meloy, A., Velasco, K., & Green, K. (2018). *Climate change needs behavior change: Making the case for behavioral solutions to reduce global warming.* Arlington, VA, USA: Rare.