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Let's think about the future: The effect of positive and negative future primes on pro-environmental behavior☆

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ABSTRACT

In an online experiment ($N = 810$), we examine whether primes on positive and negative future events unrelated to an environmental context affects pro-environmental behavior measured with an incentivized decision task. In this task, individuals decide between keeping money for themselves and investing part or the entire amount in planting trees. The results show that participants primed on future events plant significantly more trees and have higher pro-environmental intentions than participants in the control group, who were primed on leisure activities unrelated to the future. However, we find no statistically significant difference between the positive and negative future priming conditions. Exploring different potential mechanisms behind our results, we find that both future primes activated greater concern for the future and the environment, whereas the leisure prime triggered present concerns. While these results align with our research question, we cannot rule out that the leisure priming may have activated other concerns, unrelated to the present or future, potentially leading to fewer trees planted.

1. Introduction

When dealing with environmental problems, decision-makers often face a trade-off between immediate self-interest (e.g., saving time or saving money by choosing the less environmentally friendly option) and longer-term collective interests (e.g., mitigating climate change or protecting the environment). This trade-off is particularly strong when the temporal lag between actions and consequences is large (Zhu et al., 2020). Consequently, temporal distance is viewed as a major psychological barrier that hinders pro-environmental behavior in many areas, including climate change mitigation (Joireman, 2005; Zaval et al., 2015). Previous research has shown that decision-makers perceive temporal distance differently and that time perspectives affect pro-environmental behavior (Arnocky et al., 2014). Future orientation leads individuals to attach importance to future consequences and invest in the future (Joireman, 2005). Therefore, shifting people's temporal orientation toward the future could be an effective way to increase pro-environmental behavior.

In this study, we examine whether priming on future events can increase future orientation and therefore, enhance pro-environmental behavior. Priming refers to subtly highlighting specific cues that unconsciously influence people's behavior in subsequent tasks (Alempaki et al., 2019; Cohn & Maréchal, 2016). Although several studies in environmental behavioral research examine the effect of environmental priming on pro-environmental attitudes and self-reported behavior (e.g., Bimonte et al., 2020; Johe & Bhullar, 2016; Lutzke et al., 2019), we investigate whether primes on future events unrelated to an environmental context influence pro-environmental behavior measured by an incentivized decision task with true environmental consequences.

In addition, we investigate whether individuals behave differently depending on whether the framing of the primes on future events is positive or negative. Framing refers to the presentation of the same information in two different ways – as a gain (positive) or a loss (negative). According to prospect theory, loss frames are powerful because given loss aversion, losses loom larger than gains of equal size, which, in turn, motivates decision-makers to avoid losses (Kahnemann & Tversky, 1979). Therefore, priming on negative future events may create a sense of potential loss among participants, which may lead to increased

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investment to address climate change. However, there are also valid explanations for the positive effects of gain framing on pro-environmental decisions. For example, loss frames may evoke greater psychological reactance than gain frames, leading people to resist the social influence of others (Nabi et al., 2018). In addition, several pro-environmental behaviors such as climate change mitigation can be viewed as preventive behavior, and research in the fields of health and behavioral decision theory has found that gain frames are more effective in triggering preventive actions (Spence & Pidgeon, 2010). Therefore, positive primes could also increase pro-environmental behavior.

To answer our main research question of whether priming on positive and negative future events influences pro-environmental behavior, we conducted a between-subject online experiment ($N = 810$) with two treatment groups and one control group. The two treatment groups varied in terms of whether the framing of the priming questions on future events is positive or negative. The study consisted of four parts. The first part comprised our key experimental manipulation. Participants in the positive future treatment (PF) and the negative future treatment (NF) answered six questions about positive or negative events, respectively, that might happen in the future (e.g., "What are the three best (worst) things that could happen to you in the next 10 years?" or "How will people change the world for the better (the worse) in the next 30 years?"). Participants in the control group answered six questions about leisure activities that are unrelated to the future (e.g., "What are the three most important criteria for experiencing a perfect vacation?" or "How can people make the most of their leisure time?"). In the second part, we administered word-stem completion tasks to assess the mental accessibility of future orientation. In the third part, participants received an endowment and had to decide to keep the money or invest all or part of it in planting trees. Therefore, this incentivized decision task represents a trade-off between individual short-term financial rewards and long-term environmental gains. In the fourth part, we assessed the participants' pro-environmental intentions using established self-reporting scales, sociodemographic variables, and environmental attitudes.

The results show that participants primed on positive and negative future events plant significantly more trees than those primed on leisure activities. However, we find no statistically significant difference between the positive and negative future priming conditions. Priming on both positive and negative future events results in a statistically significant increase in the number of trees planted of about 10 % (equivalent to one additional tree planted) compared to priming on leisure activities. In addition, we consider the effect of future primes on pro-environmental intentions and find that individuals who were primed on positive or negative future events have significantly higher pro-environmental intentions than those who were primed on leisure activities.

The word-stem completion task in the second part of the experiment allows us to explore the potential mechanisms behind the observed treatment effects. We find that the frequency of future-related words is statistically significantly higher in the future treatments compared to the control group, primed on future-unrelated leisure activities. Conversely, present-related words were more frequently observed in the control group than in the future treatments. Importantly, the focus on leisure activities in the control treatment may also have activated other concerns unrelated to the present or future. In particular, the mental accessibility of seriousness might be lower in our leisure-related control treatment compared to the future treatments, potentially leading to fewer trees planted. However, we observe a higher frequency of serious-related words only in the negative future treatment compared to both other treatments, but not when comparing the positive future treatment and the leisure-related control treatment. Although this aligns with present- and future-related concerns driving our results, based on our design, we cannot rule out the possibility that the leisure treatment may have activated other concerns influencing behavior. In addition, we observe that thinking about the future implicitly triggers environmental concerns. The findings reveal that participants in both future treatments mentioned environment-related words significantly more frequently compared to participants in the control group.

Our results contribute to the existing literature in several ways. First, the results show that making a future-related context more salient may increase pro-environmental intentions and behavior. Therefore, priming people on future events can be an effective, low-cost, and easy-to-implement way to encourage pro-environmental behavior. Second, we extend environmental research by activating future orientation through priming questions about positive and negative future events that are independent of an environmental context. This can be beneficial because some people feel pessimistic and hopeless when thinking about environmental issues, which can cause them to remain inactive (Moser, 2007). Third, this study adds to previous work that examined the impact of gain and loss framing on pro-environmental behavior (Ropret Homar & Knežević Cvelbar, 2021; Nabi et al., 2018). We find that compared to the leisure-related control condition, positive and negative future priming lead to a statistically significant increase in pro-environmental behavior, but with no significant difference in the effect between them. Fourth, we aim to provide preliminary insights into whether the observed priming effects actually operate through the proposed mechanism of future orientation. Interestingly, we find that the questions on future events activate not only future orientation as a mental concept but also environmental concerns. Furthermore, we show that people primed on leisure activities develop a more present-related mental concept than people primed on future events and that serious-related thoughts are most frequent when primed on negative future events. Finally, from a methodological point of view, we measure pro-environmental behavior with an incentivized decision task with true environmental consequences (Essl et al., 2023). Thus far, environmental priming experiments have often relied on self-reports and questionnaires as dependent variables.

2. Related literature

This study contributes to three streams of literature: (1) research on priming interventions in environmental behavioral research, (2) literature addressing the relation between future orientation and pro-environmental behavior, and (3) research on positive (gain) and negative (loss) framing in the context of environmental research.

2.1. Priming in environmental behavioral research

Priming is a well-established tool in behavioral research that refers to subtly highlighting a specific context (e.g., climate change or work environment) or identity (e.g., job identity or race) (Alempaki et al., 2019; Cohn & Maréchal, 2016). The prime often consists of meanings that activate associated memories (norms, stereotypes, attitudes, etc.) and unconsciously influence people's behavior in a subsequent task (Tulving et al., 1982). Priming is a low-cost manipulation tool that can be easily implemented using versatile techniques (e.g., word primes, visual primes, writing tasks, or questionnaires; Cohn & Maréchal, 2016).

In environmental behavioral research, several studies have examined the effect of conceptual priming on pro-environmental attitudes. For example, Johe and Bhullar (2016) prime participants on organic identity through videos and text mining and demonstrate that organic identity priming leads to significantly higher intentions to purchase organic products compared to pro-environmental identity and control conditions. Bimonte et al. (2020) prime participants with video clips on different visual stories of a smartphone's lifecycle and show that people primed on pro-environmental attitudes state a higher hypothetical willingness to pay for an eco-friendly smartphone. Danner and Thøgersen (2022) use pro-environmental online primes and show that primes with high salience are more effective for promoting pro-organic behavior in a hypothetical choice experiment than primes with low

salience. Most environmental research on priming largely uses non-incentivized, self-reported constructs, such as attitudes, willingness to pay, and intentions. An exception is Clot et al. (2021), who show that individuals primed by green product evaluations are more likely to recycle than individuals in the control group. In addition, previous environmental priming studies have in common that they use primes to highlight an environmental context. We contribute to this literature by priming participants on future events without explicitly mentioning the environmental context and analyzing the effects of this induced priming on pro-environmental behavior measured with an incentivized task.

2.2. Future orientation and pro-environmental behavior

Decisions that affect environmental issues, such as climate change, pose a combination of a temporal and a social dilemma expressed by a conflict between individual benefits in the present (e.g., eating meat) and benefits for society and the environment in the distant future (e.g., mitigating global warming) (Joireman & Liu, 2014; Khachatryan et al., 2013; Milfont et al., 2012). Therefore, in addition to social distance, temporal distance is viewed as one of the key psychological barriers that hinder pro-environmental behavior (Joireman, 2005; Zaval et al., 2015). As the long-term benefits of pro-environmental behavior often involve immediate costs, time perspectives might influence an individual's decision to act in a pro-environmental way (Arnocky et al., 2014). Future orientation is associated with attaching importance to the future consequences of present actions and attempting to restrain from fulfilling immediate desires by investing in the future, such as through pro-environmental behavior (Joireman, 2005).

Previous researchers have shown that future orientation correlates with pro-environmental attitudes (Milfont & Gouveia, 2006), intentions (Gu et al., 2020), and engagement in sustainable behavior (Carmi & Arnon, 2014; Joireman et al., 2001, 2004). For example, Joireman et al. (2001) show that higher future orientation is positively related to the intention to engage and to actual engagement in pro-environment activism. Furthermore, Joireman et al. (2004) find that preferences for public transportation are positively associated with future orientation. Gu et al. (2020) demonstrate that perceived ecological resource scarcity has a positive effect on pro-environmental behavior and environmental donation intentions only when sufficient future orientation is present. Recent work from Hoffmann et al. (2022) finds significant interaction effects of future orientation and gender on pro-environmental behavior. More future-negative-oriented males behave significantly more environmentally friendly compared to less future-negative-oriented males and future-negative-oriented females.

If sustainable behavior change can be achieved through an increased future orientation, then methods and tools are needed to activate future orientation. Recent experimental research has explored approaches to increase individuals' future orientation to trigger pro-environmental behaviors. Most of these studies use environmental issues to activate future orientation. For example, several studies try to increase future orientation by encouraging individuals to consider the impact of climate change on future generations (Milfont et al., 2012). Pahl and Bauer (2013) show that taking the perspective of a person being affected by negative environmental changes in the future increases environmental engagement. Relatedly, Hurlstone et al. (2020) activated environmental legacy motives by presenting three text passages. These passages were either about leaving a positive legacy, addressing the imbalance of power between current and future generations, or emphasizing intergenerational reciprocity, all of which were interconnected with environmental issues. Their results indicate that primes that activate the desire to build a positive legacy can increase the willingness to make sacrifices for future generations. Shrum (2021) used two writing tasks, an essay and a letter to a person living in the future, focusing on the future risks of climate change, and finds that both writing tasks increase the willingness to donate to an environmental charity compared to a control group. In addition, instead of focusing on future generations, Lee et al. (2020) reveal that projecting the self into the future to pre-experience climate change is associated with a greater tendency to perform pro-environmental behavior. Svenningsen and Thorsen (2021) find that framing climate policy actions in terms of avoiding losses for future generations leads to a higher hypothetical willingness to pay for additional climate policies than framing them in terms of regaining income for future generations.

More closely related to the present study, Zaval et al. (2015) suggest that the positive effect of future orientation on pro-environmental behavior is also identified when the individual's legacy is made salient independently of environmental issues. Furthermore, Arnocky et al. (2014) experimentally manipulated the time perspective with a concept prime in which participants have to think about a typical day in their lives either now or in the future. The authors find that in the future priming condition, individuals express significantly more environmental concern and environmental behavioral motivation than those in the present condition. In this study, we extend the literature by activating future orientation through priming questions about future events that affect the participants and society but are independent of the environmental context. In addition, we focus on actual behavior and examine whether individuals behave differently depending on whether the framing of the priming questions of future events is positive or negative.

2.3. Positive (gain) and negative (loss) framing and pro-environmental behavior

While priming focuses on activating mental associations, framing involves presenting the same information in different ways to influence people's behavior. The framing effect is a cognitive bias where "decision-makers respond differently to different but objectively equivalent descriptions of the same problem" (Levin et al., 1998). Framing often refers to the presentation of the same information in either a positive or a negative way. According to prospect theory, the seminal work by Kahneman and Tversky (1979), people tend to give more weight to losses than to gains of the same magnitude, and therefore people try harder to avoid a loss than to make a gain. Building on this cognitive bias, environmental research has examined whether loss aversion can also be applied to pro-environmental decision-making. Thus far, the findings for context framing effects in environmental research are mixed. Although the results of several theoretical and empirical studies are consistent with prospect theory, suggesting that negative framing has a greater effect on pro-environmental decision-making than positive framing (Grazzini et al., 2018; Kragt & Bennett, 2012; White et al., 2011), other studies indicate the opposite (Bimonte et al., 2020; Hurlstone et al., 2020; Spence & Pidgeon, 2010), while still others find no significant difference between the two frames (Ahn et al., 2015; Ghesla et al., 2020). One explanation for the positive effect of gain framing on pro-environmental decisions is that loss framing might be more likely to lead to psychological reactance (Nabi et al., 2018). Another explanation indicates that pro-environmental behaviors such as climate change mitigation can be viewed as preventive behavior, and as the evidence from health and behavioral decision theory shows, gain frames are more effective in triggering preventive behavior (Spence & Pidgeon, 2010).

Based on a systematic literature review of framing and pro-environmental behavior, Ropret Homar and Knežević Cvelbar (2021) conclude that real behavior has been largely neglected as an outcome variable. The authors identify a tendency that loss framings are usually equally or more effective in studies examining pro-environmental behaviors and intentions, while gain framings are more successful in changing people's beliefs or attitudes toward environmental issues (Ropret Homar & Knežević Cvelbar, 2021). Focusing on pro-environmental behavior, Grazzini et al. (2018), for example, find that hotel guests are more likely to put waste in appropriate recycling bins when a concrete message is paired with a loss-framed message. Similarly, White et al. (2011) find that compared to gain frames, loss frames lead to higher recycling behavior, even when both frames

Table 1
Priming questions for the three different treatments.

Control Group (CG)	Positive Future (PF)	Negative Future (NF)
On average, how many minutes a day do you spend on your smartphone? (Minutes)	How many years do you think it will be until artificial intelligence will be able to save the lives of many people with rare diseases by diagnosing them correctly? (Years)	How many years do you think it will be until many people are unemployed because artificial intelligence has taken over their jobs? (Years)
Which activity do you enjoy most when you do not have to work?	Where would you like to live in 5 years if you could freely choose?	Where would you never like to live in 5 years from now, if you could avoid it?
What are the three most important criteria for experiencing a perfect vacation? Name and describe them (1–2 sentences per criterion).	What are the three best things that could happen to you in the next 10 years? Name and describe them (1–2 sentences about each thing).	What are the three worst things that could happen to you in the next 10 years? Name and describe them (1–2 sentences about each thing).
Name three leisure facilities that you would like to have in your area (answer in bullet points).	Name three inventions/things that will change our society positively in the next 10 years (answer in bullet points).	Name three inventions/things that will change our society negatively in the next 10 years (answer in bullet points).
In your opinion, what are three criteria for a good TV show? (answer in bullet points)	In your opinion, what would be three advantages if in the future only self-driving cars were on the road? (answer in bullet points)	In your opinion, what would be three disadvantages if in the future only self-driving cars were on the road? (answer in bullet points)
How can people make the most of their leisure time? (2–3 sentences)	How will people change the world for the better in the next 30 years? (2–3 sentences)	How will people change the world for the worse in the next 30 years? (2–3 sentences)

increase recycling intentions. Nabi et al. (2018) show that loss framing is more effective in inducing advocacy behavior, while gain framing leads to more green attitudes. In contrast, Ahn et al. (2015) find that gain and loss frames are equally effective in increasing pro-environmental behavior, measured as reduced paper consumption.

With few exceptions,[1] most of these studies use outcome framing that claims a certain behavior will result in either a desirable environmental gain or avoidance of a detrimental environmental loss (Ahn et al., 2015; Hurlstone et al., 2014; Nabi et al., 2018; Spence & Pidgeon, 2010; White et al., 2011). At the same time, researchers examining gain–loss framing effects in the context of environmental research base their framing mainly on environmental issues. The present study differs from previous research on the effect of framing on pro-environmental behavior in that we consider a manipulation with positively and negatively framed questions on future events unrelated to outcomes and environmental context.

3. Methodology

3.1. Experimental design and procedure

To examine how priming on positive and negative future events influences pro-environmental behavior, we implemented a between-subject design with two treatment groups and one control group. The two treatment groups varied in terms of priming on future events; that is, they were primed on either positive future or negative future events. In the control group, participants were primed on leisure activities. The experimental details were pre-registered with the American Economic Association's registry for randomized controlled trials with the unique identifying numbers AEARCTR-0007529 (for the positive future treatment) and AEARCTR-0007527 (for the negative future treatment). The ethical standard was approved by the Ethics Committee of the Faculty of Business Administration, Economics and Social Sciences at the University of Bern (serial number 042021).

The study consisted of four parts.[2] The first part comprised our key experimental manipulation. We used questions to prime participants in the two treatment groups on future events. For the control questions, we have built on the papers by Cohn et al. (2014, 2015), who employed leisure-related questions in their control conditions while priming participants in the experimental treatments on their professional banking identity (Cohn et al., 2014) and prisoner identity (Cohn et al., 2015), respectively. Leisure-related questions have been used multiple times in control conditions (e.g., Balafoutas et al., 2020; Feldhaus et al., 2022), suggesting their potential efficacy. Therefore, in the control group, we adopted six questions unrelated to the future, focused on leisure activities. Based on these questions, we then developed questions about the negative and positive future. To ensure consistency, answer types were consistent across the control and treatment groups and varied from inserting a number to raising single terms and writing a specified number of full sentences. Participants in the positive (negative) future treatment answered six questions about positive (negative) events that might happen in the future. Table 1 shows the priming questions for the three different groups. In all three treatments, the six manipulation questions were posed without specifically mentioning the environmental context.

In the second part, we used word-stem completion tasks as a manipulation check. For example, participants could complete the word fragment "__ment" with a future-related word like "investment", a present-related word such as "moment", or an unrelated word like "segment." This allowed us to test whether the questions increased future or present salience. Note that the manipulation check for the activation of future orientation is presented in Section 4.3 as one potential mechanism behind our results. In addition, we checked whether future and leisure primes activate thoughts related to seriousness and environmental concerns.

In the third part, we used an incentivized experimental task to measure pro-environmental behavior (Essl et al., 2023). Participants received an endowment of GBP 0.86 (about USD 1.15) and had to decide to keep the money or invest all or part of it in planting trees. Therefore, this so-called *Tree Task* consists of a decision tradeoff between individual short-term financial rewards and long-term environmental gains. The task put individual financial rewards against people's motives for capturing carbon dioxide (CO_2) emissions by planting trees. We use planting trees as an action to mitigate climate change because trees absorb CO_2, making reforestation one of the most effective carbon capture solutions (IPCC, 2022). In the experimental instructions, we also highlighted that planting trees is a proven instrument for capturing CO_2 emissions. In this task, participants could spend any amount between zero and the total endowment in increments of GBP 0.086 to plant trees. The price to plant one tree that absorbs 20 kg of CO_2 over its lifetime was GBP 0.086. This was the actual price charged by an international forest restoration organization that planted the trees within four weeks after the participants made their decisions. Participants could select one of 11 options, that is, plant zero to 10 trees. For each option, the different investments, the amount of money that participants kept for themselves, the corresponding number of trees planted, CO_2 absorption in kilograms, and CO_2 compensation translated in car kilometers were

[1] For example, Bimonte et al. (2020) show that making a positive attribute salient (nature prime) significantly increases the probability of the willingness to pay for environmental protections and the size of the price one is willing to pay.

[2] See Appendix A in the supplementary material for the experimental material.

Choice	Your investment to fight climate change	Your remaining balance	Number of planted trees	Lifetime CO_2 offset	Lifetime CO_2 offset in car kilometers
Choice 0 trees	£ 0	£ 0.86	0	0 kg	0 km
Choice 1 tree	£ 0.086	£ 0.774	1	20 kg	80 km
Choice 2 trees	£ 0.17	£ 0.69	2	40 kg	160 km
Choice 3 trees	£ 0.26	£ 0.60	3	60 kg	240 km
Choice 4 trees	£ 0.34	£ 0.52	4	80 kg	320 km
Choice 5 trees	£ 0.43	£ 0.43	5	100 kg	400 km
Choice 6 trees	£ 0.52	£ 0.34	6	120 kg	480 km
Choice 7 trees	£ 0.60	£ 0.26	7	140 kg	560 km
Choice 8 trees	£ 0.69	£ 0.17	8	160 kg	640 km
Choice 9 trees	£ 0.774	£ 0.086	9	180 kg	720 km
Choice 10 trees	£ 0.86	£ 0	10	200 kg	800 km

Fig. 1. Choice table of the *Tree Task*.

provided (Fig. 1). To ensure that the participants correctly understood all financial and ecological consequences, we asked them four comprehension questions before they made their choice.

In the fourth part, we assessed participants' pro-environmental intentions because research has shown that intentions can predict behavior (e.g., De Leeuw et al., 2015) and much prior research in the field is based on intentions as an outcome measure (e.g., Ahn et al., 2015; Bimonte et al., 2020). To capture pro-environmental intentions, we relied on Fujii's (2006) and Mancha and Yoder's (2015) self-reporting scales, both measured on a 7-point Likert scale ranging from "extremely unlikely" to "extremely likely." Mancha and Yoder's (2015) three items measure intentions related to reducing carbon footprints, performing environmentally friendly behaviors, and stopping the waste of natural resources. The four items from Fujii (2006) were used to examine intentions related to electricity use reduction, gas use reduction, garbage reduction, and automobile use reduction. We build a composite pro-environmental intention score by taking the average of all seven items from Fujii' (2006) and Mancha and Yoder's (2015). The reliability of the measure is good (Cronbach's alpha = 0.86). In addition, we utilized self-report measures to capture pro-environmental attitudes through Tam and Chan' (2017) six-item scale, a shorter and simpler version than, for example, the New Environmental Paradigm by Dunlap et al. (2000). Participants answered all six items on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." In line with Tam and Chan (2017), we formed a composite measure of environmental attitudes by taking the average of all six items, where higher scores indicate stronger pro-environmental attitudes. The reliability of the measure is sufficient (Cronbach's alpha = 0.69). To elicit beliefs in climate change, we used the three questions on trend skepticism, attribution skepticism, and perceived impacts of climate change (Poortinga et al., 2019). Following Poortinga et al. (2019), the 4-point response scale on trend skepticism (i.e., whether the climate is changing) was dichotomized to 0 ("probably/definitely changing") and 1 ("probably/definitely not changing"). Responses regarding attribution skepticism (i.e., whether climate change is caused by nature or humans) were coded as 1 ("entirely/mainly by natural processes") and 0 ("entirely/mainly by human activity/about equally by natural processes and human activity"). The perception of climate change—how good or bad the impact of climate change is on people across the world—was measured on a scale ranging from −5 ("extremely bad") to +5 ("extremely good"). The experiment ended with questions eliciting demographics (including gender, age, education, race, political orientation, whether they have children or not, and income).

The study was conducted online on Prolific[3] between June and July 2021. On average, participants needed 13 min (SD = 7.7) to complete the study and received a flat payment of GBP 2.2 plus an additional variable payment stemming from the *Tree Task* averaging GBP 0.27 (SD = 0.31, range = GBP 0 – GBP 0.86). Participants were paid a day after the study using the tools provided by Prolific. We also provided the option for participants to receive a confirmation email once the trees were planted in Madagascar, and 24 participants chose this option.

3.2. Sample description

We determined the target sample for this study to be at least 810 (targeting 270 participants per condition) using a two-sided Wilcoxon-Mann-Whitney test, an error probability of 0.05, and a power of 0.80 to detect an effect of Cohen's d of 0.25. In total, we recruited 912 participants on Prolific. Most participants are from Europe (54 %) followed by North America (30 %) and other countries (16 %). We followed the pre-registered protocol and removed participants from the recruited sample because they failed crucial attention checks (n = 25), gave invalid responses to the priming questions (n = 10), or answered the survey too quickly (< 5 min; n = 38) or too slowly (> 60 min; n = 2). In accordance with the pre-registered protocol, we also excluded participants who believed that the climate is probably or definitely not changing, measured by trend skeptical beliefs (n = 11). Further, we removed participants who believe that climate change is a natural process, as measured by attribution skepticism (n = 30).[4] The reason to exclude participants who believe that the climate is not changing or who believe that climate change is a natural process is that these participants are unlikely to be willing to plant trees regardless of treatment. As shown in the robustness checks in Appendix B, including all or some of these

[3] Prolific is an established crowdworking online platform (Palan & Schitter, 2018).

[4] There are overlaps regarding participants who answered the survey too quickly and gave invalid responses to the priming questions (n = 1), answered the survey too quickly and failed attention checks (n = 4), trend skepticism and failed attention checks (n = 1), attribution skepticism and failed attention checks (n = 3), invalid responses to the priming questions (n = 1), answered the survey too quickly (n = 2), and trend skepticism (n = 3). Note that regarding attribution skepticism, one (n = 1) overlap occurs between answering the survey too quickly and failing the attention checks.

Table 2
Descriptive statistics: Number of trees planted.

	CG	PF	NF
Mean	5.99	7.49	7.03
SD	3.82	3.34	3.57
	PF vs. CG	NF vs. CG	NF vs. PF
Cohen's d	0.42	0.28	0.13
p values	$p < 0.001$	$p < 0.002$	$p < 0.156$

Notes: CG = Control Group, PF = Positive future treatment, NF = Negative future treatment. P-values were obtained from Wilcoxon-Mann-Whitney tests.

participants does not considerably alter the results.[5]

The main sample included 810 participants (63.8 % female, mean age: 27.8 years), of whom 294 participated in the PF treatment, 254 in the NF treatment, and 262 in the control group. Randomization between the NF treatment and the control group was successful with respect to all variables, except for the variable *Children*. Additionally, participants in the PF treatment exhibit differences from both the control group and the NF treatment in several variables. Table 6 in Appendix B provides descriptive statistics for sociodemographic variables, beliefs in climate change, and environmental attitudes for the main sample and for each treatment group separately. In the analysis, we control for all variables that show significant differences.

4. Results

4.1. Future priming and pro-environmental behavior

In this section, we examine the influence of the two different future primes on individual pro-environmental behavior measured by the *Tree Task*. Table 2 presents for each treatment group the average number of trees planted, the corresponding standard deviations, effect sizes, and p-values based on Wilcoxon-Mann-Whitney tests. The results show that participants in the PF and NF treatments plant significantly more trees than participants in the control group, who were primed on leisure activities ($p < 0.001$ for the PF treatment and $p < 0.002$ for the NF treatment compared to the control group, Wilcoxon-Mann-Whitney tests).[6] However, there is no statistically significant difference between the results for the PF and NF treatments. Fig. 2 shows the relative frequency of the trees planted by treatment.

To consider the robustness of the descriptive results, we use the following OLS regression model:

$$y_i = \beta_0 + \beta_1 PF_i + \beta_2 NF_i + \beta'_3 \boldsymbol{E}_i + \beta'_4 \boldsymbol{X}_i + \varepsilon_i, \quad (1)$$

where the dependent variable y_i is the number of trees planted by individual i, and PF_i and NF_i are binary variables indicating whether individual i was primed on positive future or negative future events, respectively. We further estimated model specifications where we control for beliefs about climate change and environmental attitude measures $\boldsymbol{E}_i$ and sociodemographic variables $\boldsymbol{X}_i$. ε_i is the idiosyncratic error term. In all model specifications, robust standard errors were estimated.

Table 3 presents the estimated coefficients of the OLS regression analysis. In line with the descriptive statistics, Specification 1 confirms that participants primed on future events plant significantly more trees than participants in the control group, who were primed on leisure activities. In Specifications 2 and 3, we additionally control for attitudes toward climate change and the environment and important sociodemographic variables, respectively.[7] Whereas the magnitude of the treatment coefficients drops slightly, they stay highly statistically significant ($p < 0.001$). This shows that both future primes play an important role over and above other individual characteristics and pro-environmental attitudes. Furthermore, we cannot reject the null hypothesis that positive and negative future primes have the same impact on planting trees (Wald test: $p = 0.124$ for Specification 1; $p = 0.774$ for Specification 2; $p = 0.856$ for Specification 3). Not surprisingly, stronger environmentally friendly attitudes and the view that climate change has a negative impact on people around the world lead to statistically significantly more planted trees.[8] In addition, we analyzed whether there is an interaction effect between the future primes and having children. The results of an OLS regression analysis suggest that when primed on the future, participants with children plant on average more trees compared to participants without children (see Table 8 in Appendix B).

4.2. Future priming and pro-environmental intentions

In addition to the main outcome variable (the number of trees planted), we investigate the effect of future primes on pro-environmental intentions. Descriptive statistics for the different experimental groups are presented in Table 4. The Wilcoxon-Mann-Whitney tests reveal that individuals who were primed on positive or negative future events have significantly higher pro-environmental intentions than those in the control group, who were primed on leisure activities ($p < 0.001$ or, respectively, $p = 0.038$). In addition, the difference between the PF and NF treatments is statistically significant ($p = 0.009$).

Furthermore, we examine the effect of positive and negative future priming on pro-environmental intentions by applying an OLS regression model, similar to Model 1, where the dependent variable y_i is the intentions score of individual i rather than the number of trees planted. All specifications in Table 5 show a positive and statistically significant effect of the positive and negative future primes on pro-environmental intentions. Whereas the magnitude of the PF treatment effect decreases when controlling for environmental attitudes (Specification 2) and sociodemographic variables (Specification 3), the statistical significance of the PF dummy variable remains stable. In contrast, the magnitude of the NF dummy increases slightly, and it is now much more precisely estimated and significant at the 5 % level. In addition, when controlling for environmental attitudes and sociodemographic variables, the observed priming effects do not differ. Furthermore, for Specifications 2 and 3 we cannot reject the null hypothesis that positive and negative future primes have the same impact on pro-environmental intentions (Wald test: $p = 0.008$ for Specification 1; $p = 0.302$ for Specification 2; $p = 0.932$ for Specification 3).

4.3. Potential mechanisms behind treatment effects

To detect potential mechanisms behind the results, we test several mental constructs that we could have released with our priming. We do this by letting research assistants, who were blind to all experimental conditions, independently categorize the words of the word-stem completion task to compare participants' mental accessibility across the treatments.[9] First, our prior suspected mechanism behind the observed treatment effects on sustainable behavior is increased future

[5] We present the robustness of the results for three different samples in Tables 9 and 10 in Appendix B. First, we include participants (n = 22) who believe that climate change is not caused by humans, measured with attribution skepticism. Second, we include participants (n = 10) who believe that the world's climate is probably or definitely not changing, measured with trend skeptical beliefs. Finally, we conduct the analysis for the total sample, including all respondents who participated in the experiment.

[6] All statistical tests are two-sided.

[7] Whether we first add the demographic or environmental control variables does not affect the significance level and the magnitude of the treatment coefficients. Results upon request.

[8] As a robustness check, we also run a negative binomial regression model. Estimates are presented in Table 7 in Appendix B.

[9] See Appendix C for the entire coding process.

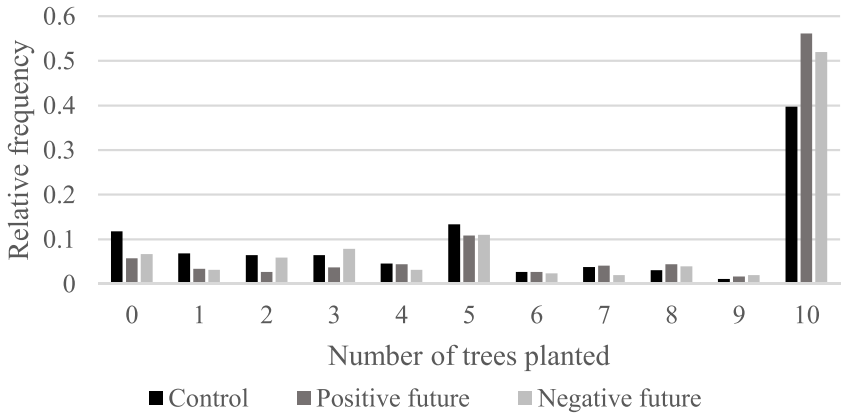


Fig. 2. Relative frequency of number of trees planted by treatment.

Table 3
Effects of priming on the number of trees planted: OLS regression.

	(1) No. of trees planted	(2) No. of trees planted	(3) No. of trees planted
PF	1.501***	1.170***	1.078***
	(0.307)	(0.297)	(0.330)
NF	1.043***	1.088***	1.021***
	(0.326)	(0.307)	(0.307)
Pro-environmental attitudes		1.197***	1.068***
		(0.188)	(0.193)
Perceived impact of CC		−0.334***	−0.295***
		(0.087)	(0.089)
Female			0.519*
			(0.282)
Age			0.026
			(0.017)
Liberal			0.264
			(0.264)
Education (> High school)			0.147
			(0.255)
Income (> GBP 50,000)			−0.119
			(0.250)
White or Caucasian			0.341
			(0.277)
Children			−0.736*
			(0.376)
Constant	5.989***	0.174	−0.486
	(0.236)	(0.716)	(0.808)
Observations	810	810	810
R-squared	0.030	0.124	0.138

Notes: The table presents estimates from ordinary least squares (OLS) regressions. Robust standard errors are shown in parentheses. The dependent variable is the number of trees planted. PF and NF are dummy variables equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Children indicates whether having children (= 1) or not (= 0). Pro-environmental attitudes are measured on a 5-point Likert scale. Perceived impact of climate change is measured on a scale from –5 ("extremely bad") to +5 ("extremely good"). *, **, and *** document significance at the 10 %, 5 %, and 1 % levels, respectively.

orientation. Thus, two research assistants categorized the words into future-related, present-related, and unrelated words. Compared to the control group primed on leisure activities, the frequency of future-related words is 53.06 % higher in the PF treatment and 38.82 % higher in the NF treatment. These differences are statistically significant (CG vs. PF, $p < 0.001$, CG vs. NF, $p < 0.001$, PF vs. NF, $p = 0.08$, Wilcoxon-Mann-Whitney test). Additionally, present-related words are more frequent in the control group compared to PF (33.65 %) and NF (29.50 %) treatments (CG vs. PF, $p = 0.005$, CG vs. NF, $p = 0.052$, Wilcoxon-Mann-Whitney test). There is no difference in the frequency of

Table 4
Descriptive statistics: Pro-environmental intentions.

	CG	PF	NF
Mean	5.13	5.56	5.31
SD	1.10	1.06	1.15
	PF vs. CG	NF vs. CG	NF vs. PF
Cohen's d	0.40	0.16	−0.23
p values	$p < 0.001$	$p = 0.038$	$p = 0.009$

Notes: CG = Control Group, PF = Positive future treatment, NF = Negative future treatment. P values were obtained from a Wilcoxon-Mann-Whitney test.

Table 5
Effects of priming on pro-environmental intentions: OLS regression.

	(1) Intentions	(2) Intentions	(3) Intentions
PF	0.428***	0.291***	0.202**
	(0.092)	(0.087)	(0.098)
NF	0.176*	0.203**	0.194**
	(0.100)	(0.092)	(0.093)
Pro-environmental attitudes		0.557***	0.543***
		(0.062)	(0.062)
Perceived impact of CC		−0.104***	−0.101***
		(0.029)	(0.030)
Female			0.208***
			(0.079)
Age			−0.004
			(0.005)
Liberal			0.024
			(0.080)
Education (> High school)			−0.011
			(0.078)
Income (> GBP 50,000)			−0.011
			(0.077)
White or Caucasian			−0.135
			(0.082)
Children			0.090
			(0.118)
Constant	5.136***	2.611***	2.776***
	(0.0684)	(0.246)	(0.269)
Observations	810	810	810
R-squared	0.026	0.197	0.209

Notes: The table presents estimates from ordinary least squares (OLS) regressions. Robust standard errors are shown in parentheses. The dependent variable is self-reported pro-environmental intentions. PF and NF are dummy variables equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Pro-environmental attitudes are measured on a 5-point Likert scale. Perceived impact of climate change is measured on a scale ranging from –5 ("extremely bad") to +5 ("extremely good"). *, **, and *** document significance at the 10 %, 5 %, and 1 % levels, respectively.

present-related words between the PF and NF treatment groups (PF vs. NF, $p = 0.421$, Wilcoxon-Mann-Whitney test). Together, these findings suggest that our manipulation was successful.

Second, priming on future events might incorporate aspects of seriousness compared to a control group primed on leisure activities. To test the mental accessibility of seriousness, two research assistants categorized the words as serious-related or -unrelated words. Results show no statistically significant differences in the frequency of serious-related words between the control group and PF treatment (CG vs. PF, $p = 0.848$, Wilcoxon-Mann-Whitney test). However, participants in the NF treatment mentioned 17.66 % more serious-related words compared to the control group (CG vs. NF, $p = 0.010$), and 15.57 % more serious-related words than in PF treatment (PF vs. NF, $p = 0.007$).

Third, thinking about the future might implicitly trigger environmental concerns. To analyze whether this is the case, two research assistants categorized the words from the word completion task into environment-related and unrelated words. The results reveal that participants in both treatments mentioned environment-related words significantly more frequently compared to participants in the control group (PF vs. CG, $p = 0.001$; NF vs. CG, $p < 0.001$, Wilcoxon-Mann-Whitney tests). Furthermore, participants in the PF treatment mentioned significantly more environment-related words than participants in the NF treatment (PF vs. NF, $p < 0.001$, Wilcoxon-Mann-Whitney test).

5. Discussion and conclusion

This paper examines whether people primed on positive or negative future events alter their pro-environmental behavior and intentions compared to a control group primed on leisure activities. In contrast to previous studies, the priming on future events is independent of any environmental context. We measure pro-environmental behavior with an incentivized task in which participants can waive a financial bonus to act environmentally friendly by planting up to 10 trees. The results reveal that participants primed on future events plant significantly more trees and show significantly stronger pro-environmental behavior compared to participants primed on leisure activities. Two interpretations arise from these results: In accordance with our research question, these findings may suggest that future priming leads to an increase in tree planting. Conversely, the results could also be interpreted as indicating that leisure priming results in fewer trees planted. To gain deeper insights into the drivers of our results, we used the word-stem completion tasks to examine different mental concepts that may have been triggered by the different primes. In line with our research question, we observe that both future primes activated greater concern for the future, whereas the leisure prime triggered present concerns. As thoughts about the future are more salient in the treatment groups, people might refrain from fulfilling their immediate desires by investing in the future through tree planting. Furthermore, we investigate whether leisure and future priming differ in activating the mental accessibility of seriousness. We observe a higher frequency of serious-related words only in the negative future treatment compared to both other treatments, but not when comparing the positive future treatment and the leisure-related control treatment. Although these results are encouraging in the sense that future versus present concerns might be driving our findings, we cannot rule out that there are other mental concepts activated by leisure and future priming that influenced pro-environmental behavior in form of tree planting.

Moreover, the results show that participants primed on future events mention significantly more environment-related words than participants in the control group. This suggests that thoughts about the future implicitly trigger concerns about the environment. This finding could prove helpful to encourage environmentally friendly behavior, as some people might feel hopeless when they are explicitly asked to think about environmental issues, which can lead to passivity (Moser, 2007). However, further research is needed to examine the relation between environmental and future thoughts.

When comparing the two future treatments, we find no significant difference between the positive and negative future primes. The literature shows mixed findings on framing effects in environmental research. Some studies find that negative framing works better (Grazzini et al., 2018; White et al., 2011), others that positive framing is more effective (Hurlstone et al., 2020; Spence & Pidgeon, 2010), and still others, like us, find no difference between framings (Ahn et al., 2015). One possible reason for these inconsistent findings is the wide range of experimental designs that examine the effects of positive and negative framings in the pro-environmental behavior context. In particular, the way in which framing is induced differs across studies.

Several limitations inherent in this study raise interesting questions for future research. First, this study, like many other priming studies, faces the challenge of identifying the exact mental concept that is activated. Although our manipulation checks support that our induced priming was successful, we cannot exclude that no other specific context or feelings are more salient than future-related ones. Second, and relatedly, our control group questions building on Cohn et al. (2014, 2015) cover leisure topics that may be perceived differently in other than time-related dimensions. Thus, rather than priming on leisure activities, future research could implement a control condition where the priming involves similar topics as the PF and NF treatments, with the only difference being that the control condition concerns the present instead of the future (e.g., Arnocky et al., 2014). Third, major concerns in priming research are replicability and persistency. Future research would benefit from analyzing the effect of making a future-related context more salient on pro-environmental behavior using different priming techniques, including videos, images, or text. Moreover, given the call for research on the long-term effects of behavioral interventions (e.g., Steg & Vlek, 2009; Steinhorst & Klöckner, 2018), it remains an open question whether the observed priming effects on pro-environmental behavior persist. To address this issue, conducting a similar experiment with a greater time gap between the priming and the pro-environmental decision task could provide insightful results. Fourth, we observe a high number of trees planted across all treatments that may be triggered by the low cost of planting a tree. It remains speculative whether comparable effects of priming on tree planting will be observed with higher stakes at hand. Furthermore, the way we presented the tree task might have made it easy for participants to see that this would be the task we are analyzing. Although the presentation was the same in all three treatments, it may have created an experimenter demand effect to encourage participants to plant more trees. Therefore, future research could explore if future priming remains as effective in fostering tree planting with increased endowments in the tree task and a more subtle way of presenting the task. Finally, the *Tree Task* asks for a specific pro-environmental behavior, namely, planting trees. Therefore, future studies could test whether future primes are similarly effective for other pro-environmental behaviors.

CRediT authorship contribution statement

Andrea Essl: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **David Hauser:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Frauke von Bieberstein:** Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

Data availability

?view_only=5a469f158ab443ebbdaa6b193becacdf

Raw data and statistical codes are available at: https://osf.io/m5akj/

Appendix A. Experimental Material

Priming questions for the three different treatments

In the first part of the study, we ask you to answer six questions completely and conscientiously. See Table 1 in the main text.

Manipulation Check – Word-stem Task

In the following part 2, please try to fill the gaps with letters to form existing words.

Examples: house household or ma machine

___ ration

___ment

___ture

___ution pl___ con___

Tree Task

In this part 3, you will receive an additional GBP 0.86 to the flat fee of GBP 2.2.

You will be asked to make a decision that may affect your final payment.

Your task

- You will decide whether you want to keep all of the GBP 0.86 for yourself, or whether you want to invest parts or all of it as a contribution to fight climate change.
- The money that you decide NOT to keep will be invested to plant trees and thus, offset carbon dioxide (CO2). An international forest restoration organization will plant the trees within the next two months.
- The price to plant one tree that offsets 20 kg of carbon dioxide (CO2) over its lifetime is GBP 0.086. This corresponds to an offset of about 80 car kilometers of an average passenger car (also see "Choice 1 tree" in the table below).
- Your decision will have an actual and true consequence for the environment. It is NOT a hypothetical decision.

Why plant trees to fight climate change?

The climate crisis will have an increasingly negative impact in the coming decades. Carbon dioxide (CO2) is regarded as a key contributor to climate change, and scientists around the globe agree that climate change can be mitigated only if carbon emissions are dramatically reduced and captured. Trees absorb CO2, making reforestation one of the most efficient and affordable carbon capture solutions. A research team from the Swiss Federal Institute of Technology in Zurich (ETH Zurich) found that restoring the world's lost forests in areas where no humans live would remove two thirds of all CO2 that is in the atmosphere because of human activity. Therefore, planting more trees will lead to a great offset of CO2 emissions and, thus, to a great contribution to the fight against climate change.

The table below shows different choices and their consequences. The first column is the number of the choice. The second column shows the different investments that you can make to fight climate change. The third column shows the amount of money that you will keep for yourself (your remaining balance). For each investment, the corresponding number of trees that will be planted is shown in column 4. Column 5 shows the total amount of CO2 that will be offset by the planted trees during their lifetime. To help you better understand the positive environmental effect of your investment, in column 6 the lifetime CO2 offset is translated into how many car kilometers travelled by an average passenger car can be offset by your choice.

Choice	Your investment to fight climate change	Your remaining balance	Number of planted trees	Lifetime CO_2 offset	Lifetime CO_2 offset in car kilo-meters
Choice 0 trees	£ 0	£ 0.86	0	0 kg	0 km
Choice 1 tree	£ 0.086	£ 0.774	1	20 kg	80 km
Choice 2 trees	£ 0.17	£ 0.69	2	40 kg	160 km
Choice 3 trees	£ 0.26	£ 0.60	3	60 kg	240 km
Choice 4 trees	£ 0.34	£ 0.52	4	80 kg	320 km
Choice 5 trees	£ 0.43	£ 0.43	5	100 kg	400 km
Choice 6 trees	£ 0.52	£ 0.34	6	120 kg	480 km
Choice 7 trees	£ 0.60	£ 0.26	7	140 kg	560 km
Choice 8 trees	£ 0.69	£ 0.17	8	160 kg	640 km
Choice 9 trees	£ 0.774	£ 0.086	9	180 kg	720 km
Choice 10 trees	£ 0.86	£ 0	10	200 kg	800 km

You are asked to select ONE of the choices.

Example

Suppose you select "Choice 8 trees":

- You invest GBP 0.69 (column 2) of your GBP 0.86 to fight climate change.
- Thus, you keep GBP 0.17 for yourself (column 3).
- The money that you invest to fight climate change will be used to plant 8 trees (column 4) that lead to the trees' lifetime CO2 offset of 160 kg (column 5).
- This means that the lifetime CO2 absorption of the 8 trees planted will offset about 640 car kilometers (column 6) travelled by an average passenger car.

Comprehension questions
Please assume that you selected "Choice 3 trees".
How much money in GBP do you invest to fight climate change?
How much money in GBP do you keep for yourself?
How many trees are planted with the money you invest to fight climate change?
How much CO_2 do you offset in kg?
Your decision
Please select your "Choice" that will be implemented. (Dropdown menu ranging from Choice 0 trees to Choice 10 trees)
How much money in GBP do you keep for yourself based on your selected "Choice"?
How much CO_2 do you offset in kg based on your selected "Choice"?
If you would like a confirmation e-mail after the trees for this study have been planted, please write us an e-mail.
Scales
Green intention:
The three items by Mancha and Yoder, (2015) ask the participants whether they will, intend or plan to behave green.
Item 1: I will try to reduce my carbon footprint in the forthcoming month.
Item 2: I intend to engage in environmentally friendly behavior in the forthcoming month.
Item 3: I plan to stop wasting natural resources in the forthcoming month.
Fujii (2006) examined four types of environmental intentions
Item 4 (Electricity): I intend to turn off lights as much as possible in the forthcoming month.
Item 5 (Gas): I intend to spend less time in the shower in the forthcoming month.
Item 6 (Package): I intend to buy goods with less packaging in the forthcoming month.
Item 7 (Transportation): I intend to use more environmentally friendly means of transport in the forthcoming month.
*Environmental attitudes - Scale according to Tam and Chan (2017)*Klicken oder tippen Sie hier, um Text einzugeben.
Participants responded on a 5-point Likert scale ranging from strongly disagree to strongly agree. In line with Tam and Chan (2017), we took the mean of all six items meaning that the higher the score the more pro-environmental view a participant has.

1: People worry too much about human progress harming the environment.
2: We worry too much about the future of the environment and not enough about prices and jobs.
3: There are more important things to do in life than protect the environment.
4: There is no point in doing what I can for the environment unless others do the same.
5: It is too difficult for someone like me to do much about the environment.
6: Modern science will solve our environmental problems with little change to our way of life.

Climate change beliefs – Scale according to Poortinga et al. (2019)
You may have heard the idea that the world's climate is changing due to increases in temperature over the past 100 years. What is your personal opinion on this? Do you think the world's climate is changing?
(4-Point Likert Scale; definitely not changing, probably not changing, probably changing, definitely changing)
Do you think that climate change is caused by natural processes, human activity, or both?
(entirely by natural processes, mainly by natural processes, entirely by human activity, mainly by human activity, about equally by natural processes and human activity, I don't think climate change is happening)
Please indicate how good or bad the impact of climate change is on people across the world? (In the following scale: −5 means extremely bad, 5 means extremely good. You can use the values in-between to indicate where you fall on the scale.)

Appendix B. Additional Analysis

Table 6
Sample characteristics and randomization check.

	Sample (n = 810)	CG (n = 262)	PF (n = 294)	NF (n = 254)	PF vs. CG p-values	NF vs. CG p-values	PF vs. NF p-values
Demographics							
Gender (% female)	**63.83**	**50.76**	**82.99**	**55.12**	<0.001	0.322	<0.001
Age in years	27.79 (9.08)	30.16 (10.30)	24.18 (6.53)	29.52 (8.98)	<0.001	0.998	<0.001
Party orientation (% liberal)	61.36	55.73	67.69	59.84	0.004	0.344	0.056
Education (% higher than high school)	55.80	58.02	47.62	62.99	0.014	0.248	<0.001
Income (% earn more than GBP 50′000)	36.42	31.68	42.52	34.25	0.008	0.534	0.048
Ethnicity (% White or Caucasian)	70.62	75.19	63.61	74.02	0.003	0.759	0.009
Children (% of having children)	18.64	28.24	7.14	22.05	<0.001	0.105	<0.001
Climate Change (CC) related variables							
Pro-environmental attitudes	3.93 (0.70)	3.89 (0.27)	4.07 (0.63)	3.81 (0.74)	0.007	0.212	<0.001
Perceived impact of CC	−3.63 (1.46)	−3.48 (1.47)	−3.80 (1.40)	−3.60 (1.52)	0.002	0.187	0.076

Notes: The table reports means and standard deviations for continuous variables and percentage frequencies for categorical variables for the full sample and for each treatment group individually. Standard deviations are given in parentheses. For categorical variables, the *p*-values were obtained from a $\widetilde{\chi}$2-test. For continuous variables, the *p*-value were obtained from Wilcoxon-Mann-Whitney tests.

Table 7
Effects of priming on pro-environmental behavior: Negative binomial model.

	(1) No. of trees planted	(2) No. of trees planted	(3) No. of trees planted
PF	0.224***	0.184***	0.174***
	(0.047)	(0.046)	(0.051)
NF	0.161***	0.170***	0.161***
	(0.051)	(0.049)	(0.049)
Pro-environmental attitudes		0.194***	0.177***
		(0.033)	(0.034)
Perceived impact of CC		−0.052***	−0.045***
		(0.015)	(0.015)
Female			0.074*
			(0.044)
Age			0.004*
			(0.003)
Liberal			0.037
			(0.041)
Education (> High School)			0.027
			(0.038)
Income (> GBP 50′000)			−0.025
			(0.038)
White or Caucasian			0.042
			(0.043)
Children			−0.120**
			(0.060)
Constant	1.790***	0.836***	0.730***
	(0.039)	(0.135)	(0.146)
Ln alpha	−1.456***	−1.650***	−1.683***
	(0.133)	(0.154)	(0.157)
Pseudo R-squared	0.004	0.018	0.021

Notes: The table presents estimates from negative binomial regressions. Robust standard errors are shown in parentheses. The dependent variable is the number of trees planted. PF and NF are dummy variables equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Children indicates whether having children (= 1) or not (= 0). Pro-environmental attitudes are measured on a 5-point Likert scale. Attribution skepticism is 1 if the individual thinks that climate change is entirely/mainly caused by natural processes and 0 if he/she thinks that climate change is entirely/mainly by human activity/about equally by natural processes and human activity. Impact of climate change is measured on a scale from –5 ("extremely bad") to +5 ("extremely good"). *, **, and *** document significance at the 10 %, 5 %, and 1 % levels, respectively.

Table 8
Interaction effects of future primes and having children on pro-environmental behavior: OLS regression.

	(1) No. of trees planted	(2) No. of trees planted	(3) No. of trees planted
PF	1.083***	0.799**	0.787**
	(0.343)	(0.328)	(0.354)
NF	0.684*	0.713**	0.658*
	(0.376)	(0.353)	(0.350)
Children	−1.302**	−1.232**	−1.517***
	(0.522)	(0.499)	(0.534)
PF #Children	2.006**	1.598*	1.574*
	(0.895)	(0.919)	(0.953)
NF #Children	1.262*	1.362*	1.410**
	(0.752)	(0.710)	(0.718)
Pro-environmental attitudes		1.204***	1.068***
		(0.189)	(0.193)
Perceived impact of CC		−0.323***	−0.288***
		(0.0880)	(0.0901)
Female			0.529*
			(0.281)
Age			0.0245
			(0.0171)
Liberal			0.284
			(0.263)
Education (> High school)			0.183
			(0.255)
Income (> GBP 50,000)			−0.0962
			(0.253)
White or Caucasian			0.332

(*continued on next page*)

Table 8 (*continued*)

	(1) No. of trees planted	(2) No. of trees planted	(3) No. of trees planted
			(0.276)
Constant	6.356***	0.533	−0.226
	(0.276)	(0.735)	(0.816)
Observations	810	810	810
R-squared	0.040	0.131	0.143

Notes: The table presents estimates from ordinary least squares (OLS) regressions. Robust standard errors are shown in parentheses. The dependent variable is the number of trees planted. PF and NF are dummy variables equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Children is a dummy variable that takes 1 for having children and 0 for not having children. Pro-environmental attitudes are measured on a 5-point Likert scale. Perceived impact of climate change is measured on a scale ranging from –5 ("extremely bad") to +5 ("extremely good"). *, **, and *** document significance at the 10 %, 5 %, and 1 % levels, respectively.

Robustness checks

We replicate the main findings of Specifications 1 to 3 of Tables 3 and 5 for three different samples in Tables 9 and 10. First, we include participants ($n = 22$) who believe that climate change is not caused by humans, measured with attribution skepticism. The results show that including these individuals has no major bearing on the findings. The treatment dummy coefficients remain highly significant and comparable in size. As a second robustness check, we include participants ($n = 10$) who believe that the world's climate is probably or definitely not changing, measured with trend skeptical beliefs. Including these participants does not affect the main results of the PF treatment either. In the NF treatment, the magnitude and statistical significance drop only marginally. Finally, we conduct the analysis for the total sample, including all respondents who participated in the experiment. Again, the results show that including all participants does not considerably alter the significance level and size of the treatment regression coefficients.

Table 9
Robustness check for different samples: Dependent variable number of trees planted.

	(1) Main sample Spec 1	(2) Incl. attribution skepticism Spec 1	(3) Incl. trend and attribution skepticism Spec 1	(4) Total sample Spec 1	(5) Main sample Spec 2	(6) Incl. attribution skepticism Spec 2	(7) Incl. trend and attribution skepticism Spec 2	(8) Total sample Spec 2	(9) Main sample Spec 3	(10) Incl. attribution skepticism Spec 3	(11) Incl. trend and attribution skepticism Spec 3	(12) Total sample Spec 3
PF	1.501***	1.549***	1.601***	1.597***	1.170***	1.165***	1.204***	1.186***	1.078***	1.058***	1.086***	1.041***
	(0.307)	(0.305)	(0.304)	(0.297)	(0.297)	(0.296)	(0.294)	(0.284)	(0.330)	(0.328)	(0.325)	(0.312)
NF	1.043***	1.054***	1.076***	1.078***	1.088***	1.106***	1.123***	1.095***	1.021***	1.046***	1.065***	1.074***
	(0.326)	(0.323)	(0.322)	(0.309)	(0.307)	(0.302)	(0.300)	(0.285)	(0.307)	(0.302)	(0.300)	(0.284)
Pro-environmental attitudes					1.197***	1.244***	1.279***	1.313***	1.068***	1.113***	1.138***	1.172***
					(0.188)	(0.184)	(0.182)	(0.172)	(0.193)	(0.189)	(0.187)	(0.178)
Perceived impact of CC					−0.334***	−0.340***	−0.323***	−0.341***	−0.295***	−0.303***	−0.283***	−0.312***
					(0.087)	(0.083)	(0.084)	(0.078)	(0.089)	(0.086)	(0.087)	(0.080)
Female									0.519*	0.556**	0.617**	0.731***
									(0.282)	(0.277)	(0.276)	(0.265)
Age									0.026	0.024	0.023	0.019
									(0.017)	(0.017)	(0.017)	(0.016)
Liberal									0.264	0.244	0.283	0.161
									(0.264)	(0.261)	(0.260)	(0.248)
Education (> High School)									0.147	0.123	0.137	0.147
									(0.255)	(0.252)	(0.251)	(0.242)
Income (> GBP 50′000)									−0.119	−0.020	−0.018	−0.001
									(0.250)	(0.247)	(0.246)	(0.239)
White or Caucasian									0.341	0.342	0.333	0.355
									(0.277)	(0.273)	(0.273)	(0.264)
Children									−0.736*	−0.622*	−0.539	−0.535
									(0.376)	(0.372)	(0.370)	(0.352)
Constant	5.989***	5.900***	5.830***	5.760***	0.174	−0.072	−0.189	−0.412	−0.486	−0.705	−0.826	−1.013
	(0.236)	(0.234)	(0.233)	(0.224)	(0.716)	(0.681)	(0.658)	(0.605)	(0.808)	(0.778)	(0.763)	(0.715)
Observations	810	832	842	912	810	832	842	912	810	832	842	912
R-squared	0.030	0.032	0.033	0.032	0.124	0.135	0.142	0.156	0.138	0.148	0.156	0.169

Notes: The table presents estimates from ordinary least squares (OLS) regressions. Column (1) to (4) show coefficients for Specification 1 of Model 1, which is equal to Specification 1 in column (1) in Table 3, for the different samples. Columns (5) to (8) for Specification 2 of Model 1, which is equal to Specification 2 in column (2) in Table 3, for the different samples. Columns (9) to (12) for Specification 3 of Model 1, which is equal to Specifications in column (3) in Table 3, for the different samples. Robust standard errors are shown in parentheses. The dependent variable is the number of trees planted. PF and NF is a dummy variable equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Children indicates whether having children (=1) or not (=0). Pro-Environmental attitudes are measured on 5-point Likert scale. Attribution skepticism is 1 if the individual think that climate change is entirely/mainly caused by natural processes and 0 if he/she thinks that climate change is 0 (entirely/mainly by human activity/about equally by natural processes and human activity). Impact of climate change is measured on a scale from −5 extremely bad to +5 extremely good. *, **, and *** document significance at the 10 %, 5 %, and 1 % levels.

Table 10
Robustness check for different samples: Dependent variable pro-environmental intentions.

	(1) Main sample Spec 1	(2) Incl. attribution scepticism Spec 1	(3) Incl. trend and attribution scepticism Spec 1	(4) Total sample Spec 1	(5) Main sample Spec 2	(6) Incl. attribution scepticism Spec 2	(7) Incl. trend and attribution scepticism Spec 2	(8) Total sample Spec 2	(9) Main sample Spec 3	(10) Incl. attribution scepticism Spec 3	(11) Incl. trend and attribution scepticism Spec 3	(12) Total sample Spec 3
PF	0.428***	0.442***	0.451***	0.459***	0.291***	0.289***	0.287***	0.306***	0.202**	0.206**	0.198**	0.234**
	(0.092)	(0.092)	(0.093)	(0.091)	(0.087)	(0.086)	(0.086)	(0.084)	(0.098)	(0.097)	(0.097)	(0.094)
NF	0.176*	0.183*	0.181*	0.213**	0.203**	0.215**	0.210**	0.227***	0.194**	0.206**	0.200**	0.222**
	(0.100)	(0.099)	(0.100)	(0.094)	(0.092)	(0.090)	(0.091)	(0.087)	(0.093)	(0.092)	(0.092)	(0.088)
Pro-environmental attitudes					0.557***	0.569***	0.589***	0.537***	0.543***	0.554***	0.569***	0.512***
					(0.062)	(0.060)	(0.060)	(0.061)	(0.062)	(0.061)	(0.061)	(0.060)
Perceived impact of CC					−0.104***	−0.099***	−0.104***	−0.095***	−0.101***	−0.096***	−0.101***	−0.089***
					(0.029)	(0.027)	(0.027)	(0.028)	(0.030)	(0.029)	(0.028)	(0.029)
Female									0.208***	0.200***	0.228***	0.209***
									(0.079)	(0.077)	(0.077)	(0.074)
Age									−0.004	−0.004	−0.005	−0.003
									(0.005)	(0.005)	(0.005)	(0.005)
Liberal									0.024	0.030	0.025	0.088
									(0.080)	(0.079)	(0.079)	(0.077)
Education (> High School)									−0.011	−0.002	0.013	0.037
									(0.078)	(0.077)	(0.077)	(0.075)
Income (> GBP 50′000)									−0.011	−0.023	−0.020	0.038
									(0.077)	(0.076)	(0.076)	(0.075)
White or Caucasian									−0.135	−0.144*	−0.137*	−0.113
									(0.082)	(0.081)	(0.081)	(0.079)
Children									0.089	0.091	0.109	0.119
									(0.118)	(0.116)	(0.116)	(0.113)
Constant	5.136***	5.119***	5.098***	5.088***	2.611***	2.579***	2.477***	2.713***	2.776***	2.748***	2.657***	2.790***
	(0.0684)	(0.0687)	(0.0695)	(0.0666)	(0.246)	(0.236)	(0.234)	(0.236)	(0.269)	(0.257)	(0.254)	(0.253)
Observations	810	832	842	912	810	832	842	912	810	832	842	912
R-squared	0.026	0.027	0.027	0.027	0.197	0.209	0.226	0.205	0.209	0.221	0.240	0.218

Notes: The table presents estimates from ordinary least squares (OLS) regressions. Columns (1) to (4) show coefficients for Specification 1 of Model 1, which is equal to Specification1 in column (1) in Table 5, for the different samples. Columns (5) to (8) for Specification 2 of Model 1, which is equal to Specification 2 in column (2) in Table 5, for the different samples. Column (9) to (12) for Specification 3 of Model 1, which is equal to Specifications in column (3) in Table 5, for the different samples. Robust standard errors are shown in parentheses. The dependent variable are self-reported environmental intentions. PF and NF is a dummy variable equal to 1 for individuals in the positive or negative future priming treatment, respectively, and 0 otherwise. Pro-environmental attitudes are measured on 5-point Likert scale. Attribution scepticism is 1 if the individual think that climate change is entirely/mainly caused by natural processes and 0 if he/she thinks that climate change is 0 (entirely/mainly by human activity/about equally by natural processes and human activity). Perceived impact of climate change is measured on a scale from −5 extremely bad to +5 extremely good. *, **, and *** document significance at the 10 %, 5 %, and 1 % levels.

Access to raw data and statistical codes

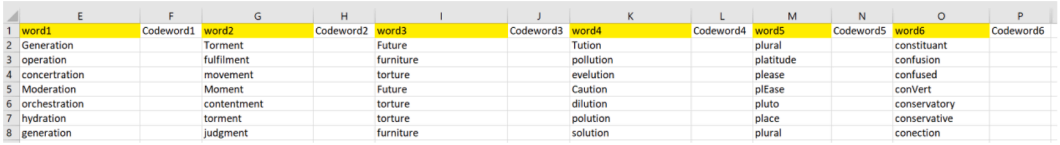
Raw data and statistical codes for the manuscript "Let's think about the future: The effect of positive and negative future primes on pro-environmental behavior" by Andrea Essl, David Hauser, and Frauke von Bieberstein can be found under the following link:
https://osf.io/m5akj/?view_only=5a469f158ab443ebbdaa6b193becacdf

Appendix C. Coding process of the word-stem completion task

The instructions to the research assistants for coding the words of the word-stem task read as follows:
"As part of our research project, we would appreciate your assistance. Your task is to code words and includes the following (see Excel):

- Sheet Wording Task: Here the task is to code each word whether it has a reference to [the] future/environment/seriousness (1) or not (0). Please write 1 or 0 in the yellow marked fields.
- Sheet Code: Please indicate here which words you have categorized as future/environment/serious-related."

The words from the word-stem task were displayed in a separate Excel file as below and research assistants had to code the words using *1* for future/environment/serious-related and *0* for unrelated words.



	E	F	G	H	I	J	K	L	M	N	O	P
1	word1	Codeword1	word2	Codeword2	word3	Codeword3	word4	Codeword4	word5	Codeword5	word6	Codeword6
2	Generation		Torment		Future		Tution		plural		constituant	
3	operation		fulfilment		furniture		pollution		platitude		confusion	
4	concertration		movement		torture		evelution		please		confused	
5	Moderation		Moment		Future		Caution		plEase		conVert	
6	orchestration		contentment		torture		dilution		pluto		conservatory	
7	hydration		torment		torture		polution		place		conservative	
8	generation		judgment		furniture		solution		plural		conection	

Research assistants coded for example the following words as future-related:

future, investment, retirement, plan
Research assistants coded for example the following words as present-related:
moment, duration, commencement
Research assistants coded for example the following words as serious-related:
concentration, argument, immigration, separation
Research assistants coded for example the following words as environmental-related:
environment, nature, temperature, pollution, plant,

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