Journal of Behavioral and Experimental Economics 107 (2023) 102105

Contents lists available at ScienceDirect

Journal of Behavioral and Experimental Economics

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

The effect of future-time referencing on pro-environmental behavior☆

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ARTICLE INFO

JEL Codes:
C91
D90
Q50

Keywords:
Linguistic-savings hypothesis
Future-time reference
Pro-environmental behavior
Language
Laboratory experiment

ABSTRACT

Can the way a language encodes time influence speakers' pro-environmental behavior? In a controlled experimental setting, we take advantage of a linguistic feature of the German language that allows speakers to use either the present or future tense when referring to an event in the future. Depending on the treatment, participants read a text about the future impacts of climate change and tree planting written in either the present or future tense. We then measured pro-environmental behavior using an incentivized task that represents a trade-off between individual immediate financial rewards and planting trees as long-term environmental gains. The results reveal a positive effect of future tense marking on the number of trees planted. We discuss construal level theory, timing precision, future orientation, and certainty of the occurrence of future climate events as potential mechanisms to explain why future-time referencing might affect individual pro-environmental behavior.

1. Introduction

Interventions such as social norms, reminders, and opt-out policies can successfully promote the pro-environmental behavior of individuals (Allcott, 2011; Ebeling & Lotz, 2015; Essl, Steffen, & Staehle, 2021; Goldstein, Cialdini, & Griskevicius, 2008). All of these interventions are communicated via language and often refer to future impacts of environmentally relevant behaviors. Given the importance of future references in pro-environmental communications, the way we talk about the future must be better understood to optimize existing interventions and create new ones. In this study, we examine whether the grammatical structure we use to refer to the future influences pro-environmental behavior in the form of tree planting.

One important characteristic in which languages differ is the extent to which they contain markers for the future tense (Dahl, 2000; Slobin, 1996). Some languages require speakers to grammatically mark future events (e.g., English and Spanish), while others do not (e.g., German and Dutch). For example, English requires the use of future markers, such as "is going to" or "will", to refer to the future (Example: "It will rain tomorrow"). Consequently, English speakers need to clearly differentiate between present and future events. In contrast, German speakers can predict rain in the present tense, stating "Morgen regnet es", which translates as "It rains tomorrow". However, they can also use the future tense "Morgen wird es regnen", which translates as "It will rain tomorrow".

The linguistic feature of future-time reference (FTR) has attracted attention because it correlates with future-oriented decisions. According to the linguistic-savings hypothesis (Chen, 2013), a language that requires speakers to disassociate the future from the present (strong FTR) can make the future appear more distant and thus, due to stronger discounting, devalue future rewards compared to a language with weak future-time referencing (weak FTR). In other words, using the present tense for future events may make people feel that the future is temporally closer, leading to more future-oriented behavior. The correlational evidence in line with this argument comes from different areas, such as saving rates, wealth levels, and health outcomes (Chen, 2013). Related studies on patience are also consistent with this hypothesis: Speakers of languages with weak FTR are, on average, more willing to accept delayed but higher payments than speakers of languages with strong FTR (Falk et al., 2018; Herz, Huber, Maillard-Bjedov, & Tyahlo, 2021; Sutter, Angerer, Glätzle-Rützler, & Lergetporer, 2018). In the area of pro-environmental behavior, the evidence is mixed. Some studies find

☆ We thank Adrian Gadient-Brügger, Stephanie Moser, Claude Messner, Michael Schulte-Mecklenbeck, and all seminar participants in the research seminar at University of Bern for their helpful suggestions. We benefited from valuable comments and suggestions at the 12th International Conference of the French Association of Experimental Economics, the research seminar at the University of Bern, and the CUSO workshop. We also thank Patrick Schönenberger and Anne von Niederhäusern for their excellent research assistance. All errors are ours. This research received funding from the Faculty of Business Administration, Economics and Social Sciences of the University of Bern (09/2020).

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https://doi.org/10.1016/j.socec.2023.102105
Received 8 September 2022; Received in revised form 5 September 2023; Accepted 18 September 2023
Available online 21 September 2023
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support for the linguistic-savings hypothesis, for instance, concerning support for a gas-tax increase (Pérez & Tavits, 2017), while others find opposite results regarding climate change concern and engagement in climate action (Zhu, Hu, Wang, & Zheng, 2020).

The majority of studies examining the effect of language structure on future-oriented behavior are based on correlations (e.g., Falk et al., 2018; K. Chen, 2013; Zhu et al., 2020). Although these correlational studies offer important insights, they cannot draw causal inferences about the effect of future-time referencing on individual behavior. Other studies work with bilingual participants and randomly vary the study's language (Ayres, Katz, & Regev, 2023; Pérez & Tavits, 2017). However, this may trigger cultural cues and lead to selection and attrition bias if participants prefer one language over another. To address these potential shortcomings in the area of patience, Chen, He, and Riyanto (2019) and Angerer, Glätzle-Rützler, Lergetporer, and Sutter (2021) used controlled experimental settings by randomly referring to future events using the present or future tense within a weak FTR language. Both studies find no causal effect of future marking on incentivized intertemporal choices. The advantage of using variations in the same language is that the researchers can keep cultural cues constant, which may affect behavior when different languages are used. The present paper is the first to investigate the causal effect of future-time reference within a language on pro-environmental behavior in the form of tree planting.

To answer our research question, we conducted a between-subject online experiment in the German language. In German, future events can be referred to in the present or future tense. The participants were randomly assigned to either the FUTURE (German with future tense marking, $n = 383$) or PRESENT (German with present tense marking, $n = 398$) treatment. First, the participants read a text about climate change and tree planting in their randomly assigned tense. Then, the participants' pro-environmental behavior was elicited with a recently developed incentivized decision task (Essl, Hauser, Suter, & von Bieberstein, 2023) using the same tense. 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 task consists of a decision trade-off between immediate individual financial and long-term environmental rewards.

In contrast to the linguistic-savings hypothesis, the results show that participants in the FUTURE treatment planted significantly more trees than participants in the PRESENT treatment. Specifically, participants in the FUTURE treatment planted an average of 0.57 more trees than participants in the PRESENT treatment. This corresponds to a 7.8% increase in the number of trees planted in the FUTURE treatment compared to the PRESENT treatment. As potential psychological mechanisms behind this result, we discuss construal level theory, timing precision, future orientation, and certainty of the occurrence of future climate events. In an online follow-up survey retargeting the subjects of the first study, we tested these mechanisms ($n = 442$). We find no statistically significant differences between the two treatments for any of the proposed mechanisms, which may be due to the low response rate (56.6% of the participants in the first study). Only for construal level theory did we find meaningful differences going in the predicted direction. According to construal level theory, events that are psychologically perceived as more distant (in this case, in the temporal dimension) are processed at a more abstract level. This leads to a more analytical mindset that gives more weight to analytical arguments and thus facilitates decision-making regarding more abstract events such as climate change (Liberman & Trope, 2008).

This study makes three main contributions to the literature. First, the study addresses the need for more experimental research regarding the effect of future marking on pro-environmental behavior. By holding the language constant, we show that participants who were exposed to future tense marking planted significantly more trees than those exposed to present tense marking. Therefore, this research is particularly relevant for more effective behavioral interventions and communication strategies to foster pro-environmental behavior. Second, this paper joins a growing body of economic literature that examines how language influences individual decision-making (He, Riyanto, Tanaka, & Yamada, 2020; Chen, 2013; Lien & Zhang, 2020; Xing, 2021). In particular, we contribute in two ways to the general research on the linguistic-savings hypothesis. This hypothesis has been experimentally investigated in the area of patience regarding delayed but higher payments (Angerer et al., 2021; Chen et al., 2019); however, similar studies in other domains are desirable. Further, given that the main result is not in line with the linguistic-savings hypothesis, the effect of future-time referencing on future-oriented behavior might be more complex than previously thought. This is among the few studies that have examined the possible underlying mechanisms behind these results. While the results of our follow-up survey go in the direction of the reasoning of construal level theory, no significant differences were found between the FUTURE and the PRESENT treatments. Thus, a more in-depth investigation into these underlying mechanisms is warranted. Furthermore, other important factors, such as the time horizon and the gain and/or loss framing of the mentioned consequences, might also be at play. Third, we address concerns regarding the measurement of pro-environmental behavior by using a consequential environmental decision task. Previous environmental research examining the linguistic structure was based on self-reported and observational pro-environmental behavior. We used an incentivized environmental decision task in a controlled experimental setting.

2. Related literature

2.1. Future-time referencing and intertemporal preferences

Languages have different requirements for their speakers in terms of encoding time (Dahl, 2000; Slobin, 1996). Chen, 2013 introduced the linguistic-savings hypothesis, which links language structure and decision-making. The hypothesis states that languages that grammatically separate the present and future lead their speakers to less future-oriented behavior than languages in which speakers can refer to future events by using the present tense. Strong FTR languages, such as English and French, require a dedicated marking of the future, while weak FTR languages, such as German and Mandarin, do not (Dahl & Velupillai, 2011; Chen, 2013). Thus, weak FTR languages can use the same grammatical tense for the present and the future.

People tend to discount future costs and rewards, known as temporal discounting (Frederick, Loewenstein, & O'Donoghue, 2002; Ramsey, 1928; Solnick, Kannenberg, Eckerman, & Waller, 1980). Therefore, the further in the future an outcome appears to be, the more its potential costs and benefits might be discounted. The grammatical distinction between strong FTR and weak FTR languages might influence agents' behavior, particularly future-oriented behavior (Chen, 2013). According to the linguistic-savings hypothesis, the use of a separate grammatical form to talk about the future potentially makes future events appear subjectively further away from the speaker's now, resulting in less future-oriented behavior. In contrast, using the present tense to refer to future events leads to less temporal discounting. This may make people feel that the future is temporally closer to the present, fostering future-oriented behavior.

Several correlational studies support the linguistic-savings hypothesis. People who speak a strong FTR language smoke more, are more obese, exercise less, and practice safer sex less often (Chen, 2013). They are also less patient in intertemporal choice tasks (Ayres et al., 2023; Falk et al., 2018; Herz et al., 2021; Sutter et al., 2018) and have a lower propensity to save money than people from countries with weak FTR

languages (B. Guin, 2016; Chen, 2013). In addition, companies that use strong FTR working languages engage less in future-oriented behaviors, such as corporate social responsibility and research and development investments (Liang, Marquis, Renneboog, & Sun, 2018). Many of these studies are based on cross-country correlative comparisons with survey data (Chen, 2013; Falk et al., 2018; Liang et al., 2018). Other studies compare the behavior of people in bilingual regions, where some inhabitants speak a weak and some a strong FTR language (B. Guin, 2016; Herz et al., 2021; Sutter et al., 2018). However, these studies do not experimentally vary the language of the study participants. Languages may inherently contain cultural cues that influence future-oriented behavior. Cultural differences that are independent of a language's future-time referencing could therefore be a cause of these effects. Other studies use participants who are bilingual in a weak and a strong FTR language and randomly assign in which language participants read the instructions (Ayres et al., 2023). This experimental setup can also evoke cultural cues through the assigned language. In addition, there is a risk of attrition and selection bias, as participants may prefer one or the other language. Thus, in all of these studies, unobserved cultural differences correlating with the language could affect the results. In fact, a large strand of economic literature uses language as a proxy for culture (Alesina & Ferrara, 2005; Desmet, Ortuño-Ortín, & Wacziarg, 2012; Hübner & Vannoorenberghe, 2015).

To address this shortcoming, experimental studies have been used to investigate the causal effect of future-time referencing on patience. In a controlled experimental setting, Chen et al. (2019) and Angerer et al. (2021) test the linguistic-savings hypothesis by using weak FTR languages that allow future-time referencing in the present and future tenses. By keeping the language constant, these studies hold cultural cues constant. In the Chinese language, Chen et al. (2019) manipulated the use of present versus future tense in the instructions that asked participants to choose between smaller-sooner and larger-later rewards. The authors found no causal effect of language structure on incentivized intertemporal choices. Angerer et al. (2021) replicated these results for the German language.

2.2. Future-time referencing and pro-environmental behavior

Further investigation of future-time referencing is particularly relevant for pro-environmental behavior. Pro-environmental behavior is an important area of future-oriented behavior, often involving present individual costs for collective rewards at some undefined point in the future. Building on the linguistic-savings hypothesis, environmental research has examined whether future-time referencing influences pro-environmental decision-making. Thus far, the findings are mixed. In line with the linguistic-savings hypothesis, empirical research has suggested that speakers of a weak FTR language are more likely to choose household products that are perceived as better for the environment (Mavisakalyan, Tarverdi, & Weber, 2018), to support a pro-environmental policy in the form of a gas-tax increase (Pérez & Tavits, 2017), and to be concerned about the negative environmental impacts of tourism (Kim & Filimonau, 2017). In contrast, Zhu et al. (2020) indicate that in countries with a higher percentage of speakers of strong FTR languages, the population has on average higher climate concerns, and lower carbon emissions and energy use. The authors argue that the greater temporal distance created by future tense marking improves the understanding of the complexity of climate change and increases perceived timing precision and certainty about climate change, consequently leading to more pro-environmental behavior.

Most environmental research on language structure is correlational. An exception is the study by Pérez and Tavits (2017), in which the interview language was randomly assigned to Estonian (weak FTR language) or Russian (strong FTR language) bilingual participants. The researchers find that respondents who were interviewed in Estonian were significantly more likely to support a gas-tax increase to protect the environment than those who were interviewed in Russian. We contribute to this literature by experimentally testing the causal effect of future-time referencing within the same language on investments in planting trees. Specifically, we make use of the linguistic features of the German language, in which speakers can use the future tense or present tense for future events. We hold cultural cues constant by randomly referring to future events using the present or future tense. Furthermore, this approach prevents attrition and selection bias. In addition, all previous studies investigating the effect of future-time referencing on pro-environmental behavior have in common that they use observational or survey data. In contrast, we use an incentivized environmental decision task to measure actual behavior in a controlled setting.

3. Online lab experiment

3.1. Experimental design and procedure

We conducted a between-subject online experiment to examine whether there is a causal effect of future-time referencing on individuals' decisions to plant trees. This research question is investigated by using the German language, which allows us to refer to future events using the present or future tense. The study was pre-registered on the platform of the American Economic Association's (AEA's) registry for randomized controlled trials (AEARCTR-0008477) and received ethical approval from the Faculty of Business Administration, Economics and Social Sciences of the University of Bern (serial number: 222021).

German speakers living in Germany, Austria, or Switzerland were randomly assigned to two treatments, which differed in terms of the tense used in the German instructions. In the PRESENT treatment, we used the present tense to refer to future events ($n = 398$). In the FUTURE treatment, we used the future tense ($n = 383$). Because both versions sound natural to German speakers, we eliminate any possible experimenter demand effect (Chen et al., 2019).

The study consists of three parts.[1] In the first part, participants were asked to read a text about possible negative future impacts of climate change on the planet and humanity, and the benefits of carbon absorption through the planting of trees. Depending on the treatment, the text was in either the present tense (e.g., «Die Klimakrise hat in den nächsten Jahrzenten zunehmend negative Auswirkungen.») or the future tense (e.g., «Die Klimakrise wird in den nächsten Jahrzehnten zunehmend negative Auswirkungen haben.»).[2] To make the grammatical time reference more salient, all verbs were printed in bold in the experimental instructions (see Fig. 1). To ensure that the participants read the text carefully, they had to answer a control question.

In the second part, we used the Tree Task by Essl et al. (2023). The Tree Task is an incentivized decision task used to measure participants' behavior regarding the environment. Participants received an endowment of GBP 0.86 (about USD 1.15) and had to decide whether they wanted to keep the money for themselves or spend some or all of it on planting trees. In the experimental instructions, we mentioned that planting trees could be considered a climate change mitigation measure as it is an effective solution for capturing carbon dioxide emissions (IPCC, 2022). The Tree Task pits individual immediate financial rewards against long-term environmental gains. The cost of planting one tree that absorbs 20 kg of carbon dioxide over its lifetime was GBP 0.086. Participants had to choose one of 11 options for real implementation, that is, plant 0 (= GBP 0) to 10 (= GBP 0.86) trees. For each option, we provided the consequences in terms of the monetary investment, carbon dioxide absorption in kilograms, and carbon dioxide compensation

[1] Experimental instructions and survey questions are available in the online supplementary material.

[2] Present tense (translated into English): "The climate crisis has an increasingly negative impact in the coming decades" vs. future tense (translated into English): "The climate crisis will have an increasingly negative impact in the coming decades."

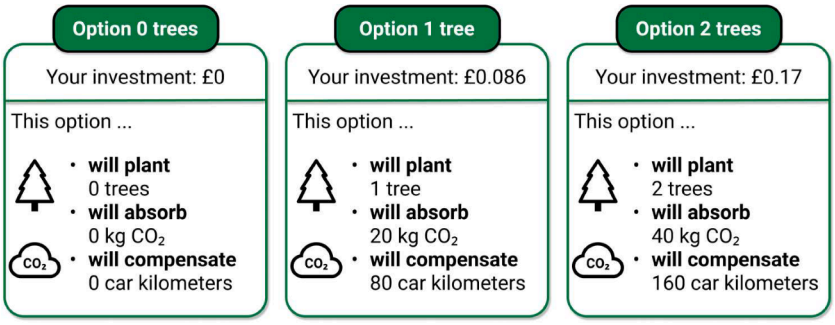

Fig. 1. Excerpt from the display of the options of the Tree Task in the FUTURE treatment (translated into English).

translated into car kilometers (see online supplementary material). To describe the future consequences of the different options, the present tense was used in the PRESENT treatment and the future tense in the FUTURE treatment. The types of future-time referencing used in the PRESENT and FUTURE treatments differed in 58 places across the first and second parts of the study.[3] An international forest restoration organization planted the trees within four weeks after the experiment (participants were aware of this information) in Madagascar. To ensure that the participants correctly understood the financial and ecological consequences of their decision, they were asked to answer several comprehension questions.

In the third part, we used a questionnaire consisting of self-report scales on pro-environmental intentions (Fujii, 2006; Mancha & Yoder, 2015), beliefs about climate change (Poortinga, Whitmarsh, Steg, Böhm, & Fisher, 2019), and general environmental views (ISSP Research Group, 2012). Specifically, behavioral intentions were measured with descriptions of nine behavioral intentions regarding the environment (e.g., "I will turn off lights as much as possible in the forthcoming month"). Three items measuring behavioral intentions were previously used by Mancha and Yoder (2015), three items were previously used by Fujii (2006), and three items were newly formulated.[4] The participants were asked to rate the items on a 7-point Likert scale ranging from 1 ("extremely unlikely") to 7 ("extremely likely"). The reliability of the measure is good (Cronbach's alpha = 0.804). To elicit people's beliefs about climate change, three questions from Poortinga et al. (2019) work were asked. Following Poortinga et al. (2019), the 4-point response scale on the existence of climate change was dichotomized to 0 ("probably/definitely changing") and 1 ("probably/definitely not changing"). The responses to the question of whether climate change is caused by nature or humanity were coded as 0 ("entirely/mainly by human activity/about equally by natural processes and human activity") and 1 ("entirely/mainly by natural processes/I don't think climate change is happening"). Furthermore, participants were asked how effective they considered tree planting as a climate change mitigation measure (4-point Likert scale ranging from "very effective" to "not effective at all"). The study ended with demographic (including gender, age, education, political ideology, culture, income, country of birth and residence, years in country of birth and residence, education) and language-related questions (German proficiency and frequency).[5]

The experiment was conducted online on the crowdsourcing platform Prolific from November 11 to November 26, 2021. Prolific is an established crowd-working online platform (Palan & Schitter, 2018). The experimental sessions lasted, on average, 16 minutes (median = 10.43 min), with a flat payment of GBP 1.24 per participant.[6] The mean additional payment for the Tree Task was GBP 0.23 (range: GBP 0 to 0.86, SD = 0.32). The median minimum payment that has to be guaranteed on Prolific is GBP 6 per hour. Thus, in this experiment, the flat payment secured the median minimum payment with about 7 GBP/hour and the additional endowment for planting trees corresponds to an hourly rate of about 5 GBP/hour.[7] Participants were offered the option of receiving a confirmation email after the trees were planted.

3.2. Sample characteristics

We targeted a final sample of 824 subjects (412 participants per treatment group) to detect an effect of Cohen's d of 0.2 with an error probability of 0.05 and a power of 0.80 (based on a two-sided Wilcoxon-Mann-Whitney test). We used a two-sided test given that the literature on future-time referencing and pro-environmental behavior has not provided clear results. In total, 877 people participated in the experiment. In accordance with the pre-registered protocol, participants who did not complete the Prolific task within 60 min of starting ($n = 4$), who failed crucial attention checks ($n = 2$) or incorrectly answered a control question ($n = 21$), who do not believe in climate change ($n = 23$) or the positive impact of planting trees as a climate change mitigation measure ($n = 6$), and who do not have German as their native language ($n = 46$) were excluded.[8] The exclusion criteria reduced the main sample to 781 subjects (53% female; mean age: 28 years, SD = 9.36), of whom 383

[3] To investigate the impact of future marking on investments in planting trees, it is important to provide some context to participants (i.e., mentioning the consequences of climate change, the benefits of planting trees, etc.). This context naturally contains many future references. Thus, we had to decide which tense to use when referring to the future in the first part. To avoid favoring one or the other tense, we decided to use tense marking consistently in part 1 and part 2. Note that given this decision for consistency, we cannot be sure if both parts or only one of the parts of the text is needed for the results.

[4] In the FUTURE treatment, four behavioral intentions were presented in the future tense, whereas in the PRESENT treatment the identical four items were formulated in the present tense to refer to future events. Additionally, in both treatments five items were formulated tense-neutral using "intend" and "plan". The order of the items was randomized. However, we find no statistically significant difference between the two treatment groups for either the four manipulated items or the five temporally neutral formulated items.

[5] Demographic and language-related questions are available in the online supplementary material.

[6] At the time of the experiment, the exchange rate was USD 1 = GBP 0.748.

[7] The exact calculations, given the median time of 10.43 minutes that the participants spent on the task, are $1.24 \times 60/10.43 = 7.13$ GBP/hour (about 9.5 USD/hour at the time of the experiment) for the flat payment and $0.86 \times 60/10.43 = 4.95$ GBP/hour for the additional endowment for planting trees (about 6.60 USD/hour at the time of the experiment).

[8] There are overlaps regarding participants who do not speak German as their native language and do not believe in climate change (n = 3), who do not speak German as their native language and failed the control question (n = 1), who failed the control question and do not believe in climate change (n = 1), and who do not believe in climate change and the positive impact of planting trees (n = 1). In the Table A2 in the Appendix, we present the robustness of the results by including participants who do not believe in climate change and/or the positive impact of planting trees as climate change mitigation measure as well as participants who do not speak German as their native language.

Table 1
Sample characteristics and randomization check.

	Sample (n = 781)	FUTURE (n = 383)	PRESENT (n = 398)	FUTURE vs. PRESENT p values
Demographics				
Gender (% female)	**52.75**	**54.05**	**51.51**	0.477
Age in years	28.03	27.80	28.30	0.974
	(9.36)	(8.74)	(9.92)	
Conservative ideology	3.48	3.41	3.54	0.268
	(1.64)	(1.62)	(1.66)	
Culture (% German culture)	91.17	91.64	90.70	0.643
Income				0.755
Less than £10,000 (n = 213)	27.66	26.19	29.59	
£10,000–£29,000 (n = 230)	29.87	30.16	29.59	
£29,000–£59,000 (n = 209)	27.14	28.57	25.77	
More than £60,000 (n = 118)	15.32	15.08	15.56	
Country of birth (% of German-speaking country GER, AUT, SUI)	98.08	97.24	98.96	0.679
Germany (n = 689)	88.22	88.77	87.68	
Austria (n = 130)	7.04	7.31	6.78	
Switzerland (n = 22)	2.82	2.87	2.76	
Country of residence (% of German- speaking country GER, AUT, SUI)	100	100	100	0.757
Germany (n = 701)	89.76	89.56	89.95	
Austria (n = 55)	7.04	7.57	6.53	
Switzerland (n = 25)	3.20	2.87	3.52	
Years in country of birth	17.41	17.58	17.26	0.004
	(2.73)	(2.32)	(3.07)	
Years in country of residence	24.52	24.80	24.24	0.196
	(11.02)	(10.47)	(11.53)	
Education				0.666
University (n = 367)	46.99	45.95	47.99	
Vocational training (n = 96)	12.29	13.32	11.31	
Secondary school/high school and less (n = 318)	40.72	40.73	40.70	
Language-related variables				
German proficiency	9.78	9.80	9.77	0.167
	(0.50)	(0.52)	(0.49)	
German frequency	9.78	9.77	9.78	0.579
	(0.73)	(0.75)	(0.71)	
Climate change–related variables				
Pro-environmental attitudes	3.99	4.02	3.96	0.178
	(0.66)	(0.65)	(0.67)	

Note. The table reports the 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 chi-square test. For the continuous variables, the p values were obtained from Wilcoxon-Mann-Whitney tests. Conservative ideology refers to a political ideology and was measured on a 10-point scale ranging from 1 ("completely left/liberal") to 10 ("completely right/conservative"). Culture was measured by asking participants which culture they see themselves most influenced by. Culture is a binary variable that takes 1 for a culture other than German (non-German culture) and 0 for German culture. German proficiency was measured on a 10-point scale ranging from 1 ("not proficient at all") to 10 ("very proficient"). German frequency was measured on a 10-point scale ranging from 1 ("very rarely") to 10 ("very often"). Environmental attitudes were measured with six items on a numerical 5-point Likert scale.

received the FUTURE treatment, and 398 received the PRESENT treatment. Table 1 provides descriptive statistics for the sociodemographic variables, language-related variables, and environmental attitudes for the main sample and the treatment groups separately. Randomization between the two treatment groups was successful for all variables, except the number of years lived in the country of birth. We control for the variable years lived in the participants' countries of birth in the regression analyses.

4. Results

On average, participants in the PRESENT treatment planted 7.30 trees (SD = 3.59), and those in the FUTURE treatment planted 7.87 trees (SD = 3.45). According to the Mann-Whitney rank sum test, and contrary to the linguistic-savings hypothesis, participants in the FUTURE treatment planted statistically significantly more trees than those in the PRESENT treatment ($p = 0.008$). Fig 2. shows the cumulative distribution function of the number of trees planted per treatment.

To examine the stability of the treatment effects, we estimate the following OLS regression model

$$y_i = \beta_0 + \beta_1 FUTURE_i + \beta'_3 \boldsymbol{X_i} + \beta'_4 \boldsymbol{C_i} + \varepsilon_i, \quad (1)$$

where the dependent variable y_i is the number of trees planted by individual i. The dummy variable $FUTURE_i$ takes the value of 1 if individual i is assigned to the FUTURE treatment and 0 if he or she participates in the PRESENT treatment. We also estimated model specifications in which we control for sociodemographic $\boldsymbol{X_i}$ and culture and language-related variables $\boldsymbol{C_i}$. ε_i is the idiosyncratic error term. In all model specifications, we estimated robust standard errors.

Table 2 presents the regression results. All specifications show a statistically significant positive effect of the FUTURE treatment on the number of trees planted. Specification 1 contains the overall treatment effect. As shown by the descriptive statistics, participants in the FUTURE treatment group planted 0.57 more trees compared to participants in the PRESENT treatment group. This corresponds to a 7.8% increase in the number of trees planted. The magnitude and significance level of the treatment effect remain stable when we control for sociodemographic variables (Specification 2) and for culture and language-related variables (Specification 3). In addition, gender and age have a statistically significant impact on the number of trees planted, with women and older people planting more trees. The size of the FUTURE treatment effect is slightly less than half of the magnitude of the impact observed between identifying as female and identifying with other gender identities. Furthermore, the results reveal a significant negative correlation between conservative political ideology and the number of trees

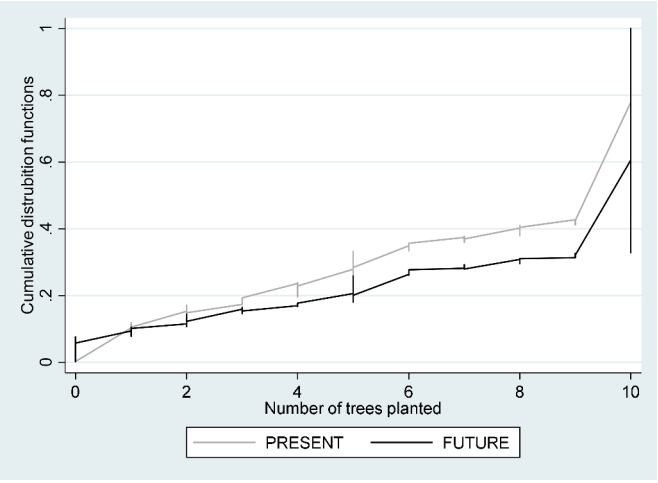

Fig. 2. The graph shows the cumulative distribution function of the number of trees planted per treatment.

planted. This finding is in line with previous research showing that people with a liberal ideology tend to have higher environmental concerns (Xiao & McCright, 2007) and support more government spending on environmental protection (McCright, Xiao, & Dunlap, 2014), compared to their conservative counterparts. In addition, German proficiency and frequency have no significant impact, possibly because we excluded all participants who do not have German as their native language.

Furthermore, we test whether future-time referencing has different effects on the number of trees planted by people with different environmental attitudes. The treatment effects were estimated by restricting the sample to those who have strong environmental attitudes, as described in the pre-registered protocol. Environmental attitudes were measured with six items on a numerical 5-point Likert scale (ISSP Research Group, 2012). Strong environmental attitudes are defined if the mean of the six items is equal to or higher than 3. Specifications 4–6 of Table 2 show that the statistical significance of the FUTURE treatment remains the same, whereas the magnitude of the FUTURE treatment coefficient is slightly higher for the restricted sample than for the main sample.

Table 2
Effect of the FUTURE treatment on the number of trees planted: OLS regression.

	Main sample			Excl. weak environmental attitudes		
	No. trees (1)	No. trees (2)	No. trees (3)	No. trees (4)	No. trees (5)	No. trees (6)
FUTURE	0.568**	0.494**	0.472*	0.589**	0.552**	0.519**
	(0.253)	(0.250)	(0.253)	(0.247)	(0.250)	(0.252)
Female		1.157***	1.178***		0.968***	0.954***
		(0.265)	(0.274)		(0.269)	(0.279)
Age in years		0.046***	0.033*		0.031**	0.018
		(0.014)	(0.017)		(0.014)	(0.017)
Income						
£10,000–£29,000		0.369	0.387		0.275	0.312
		(0.338)	(0.339)		(0.339)	(0.339)
£29,000–£59,000		0.341	0.344		0.311	0.294
		(0.361)	(0.364)		(0.360)	(0.363)
More than £60,000		0.553	0.537		0.516	0.501
		(0.450)	(0.455)		(0.443)	(0.449)
Education						
Vocational training		–0.044	–0.082		0.107	0.072
		(0.403)	(0.410)		(0.403)	(0.408)
Secondary school/high school and less		0.107	0.078		–0.111	–0.105
		(0.294)	(0.296)		(0.297)	(0.299)
Conservative ideology		–0.395***	–0.398***		–0.223**	–0.223**
		(0.088)	(0.088)		(0.093)	(0.094)
Non-German culture			–0.530			–0.214
			(0.466)			(0.463)
German proficiency			–0.110			0.164
			(0.270)			(0.281)
German frequency			–0.041			–0.069
			(0.160)			(0.176)
Years in country of birth			0.007			0.029
			(0.048)			(0.0477)
Years in country of residence			0.016			0.017
			(0.015)			(0.015)
Constant	7.302***	6.483***	7.898**	7.579***	6.742***	5.311*
	(0.180)	(0.631)	(3.067)	(0.178)	(0.637)	(3.194)
N	781	768	768	725	712	712
R^2	0.006	0.077	0.081	0.008	0.043	0.047

Note. The table presents ordinary least squares estimates. Robust standard errors are in parentheses. The dependent variable is the number of trees planted, either for the main sample (specifications 1–3) or for the restricted sample, excluding those with weak environmental attitudes (specifications 4–6). Environmental attitudes were measured with six items on a numerical 5-point Likert scale. Weak pro-environmental attitudes are present if the mean is less than 3. The reference group for the FUTURE treatment is the PRESENT treatment. Female is a binary variable that takes a value of 1 for women and 0 for men and non-binary and other individuals. The reference group for the income variable are participants who earn less than GBP 10,000. The reference group for the education are participants with a university degree. Conservative ideology refers to a political ideology and is measured on a 10-point scale ranging from 1 ("completely left/liberal") to 10 ("completely right/conservative"). Culture was measured by asking participants which culture they see themselves most influenced by. Culture is a binary variable taking 1 for a culture other than German (non-German culture) and 0 for German culture. German proficiency was measured on a 10-point scale ranging from 1 ("not proficient at all") to 10 ("very proficient"). German frequency was measured on a 10-point scale ranging from 1 ("very rarely") to 10 ("very often"). Thirteen observations are omitted due to missing observations for income ($n = 11$) and political ideology ($n = 2$), which were non-required questions. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table 3
Extensive and intensive margins.

	Main sample						Weak environmental attitudes excluded					
	Prob. of planting trees (1)	Prob. of planting trees (2)	Prob. of planting trees (3)	No. trees cond. (4)	No. trees cond. (5)	No. trees cond. (6)	Prob. of planting trees (7)	Prob. of planting trees (8)	Prob. of planting trees (9)	No. trees cond. (10)	No. trees cond. (11)	No. trees cond. (12)
FUTURE	–0.002	–0.015	–0.020	0.617***	0.578***	0.555**	–0.039	–0.038	–0.049	0.664***	0.636***	0.606***
	(0.133)	(0.141)	(0.142)	(0.215)	(0.217)	(0.219)	(0.151)	(0.154)	(0.151)	(0.213)	(0.217)	(0.219)
Female		0.626***	0.660***		0.555**	0.539**		0.575***	0.606***		0.476**	0.427*
		(0.153)	(0.155)		(0.234)	(0.241)		(0.168)	(0.171)		(0.236)	(0.242)
Age in years		0.017*	0.016		0.031**	0.019		0.013	0.009		0.020*	0.011
		(0.010)	(0.011)		(0.012)	(0.015)		(0.011)	(0.011)		(0.012)	(0.015)
Income												
£10,000–£29,000		0.378*	0.390**		0.022	0.035		0.363*	0.365*		–0.006	0.036
		(0.195)	(0.194)		(0.299)	(0.300)		(0.214)	(0.212)		(0.299)	(0.299)
£29,000–£59,000		0.103	0.120		0.227	0.219		0.077	0.078		0.259	0.245
		(0.206)	(0.208)		(0.304)	(0.306)		(0.224)	(0.225)		(0.300)	(0.303)
More than £60,000		0.116	0.131		0.485	0.451		0.130	0.140		0.412	0.398
		(0.236)	(0.237)		(0.371)	(0.376)		(0.269)	(0.269)		(0.367)	(0.371)
Education												
Vocational training		0.018	0.034		–0.081	–0.124		0.098	0.100		0.025	–0.001
		(0.215)	(0.218)		(0.341)	(0.346)		(0.264)	(0.266)		(0.341)	(0.346)
Secondary school/ high school and less		0.160	0.130		–0.064	–0.055		0.010	–0.011		–0.124	–0.089
		(0.174)	(0.177)		(0.256)	(0.258)		(0.192)	(0.195)		(0.258)	(0.258)
Conservative ideology		–0.140***	–0.140***		–0.248***	–0.251***		–0.093	–0.092		–0.137*	–0.137*
		(0.047)	(0.047)		(0.076)	(0.077)		(0.058)	(0.056)		(0.077)	(0.078)
Non-German culture			–0.258			–0.252			–0.062			–0.203
			(0.218)			(0.407)			(0.257)			(0.415)
German proficiency			–0.184			0.084			–0.095			0.284
			(0.153)			(0.239)			(0.162)			(0.251)
German frequency			–0.125			0.056			–0.056			–0.043
			(0.120)			(0.137)			(0.109)			(0.158)
Years in country of birth			–0.008			0.019			–0.001			0.035
			(0.036)			(0.039)			(0.034)			(0.039)
Years in country of residence			0.000			0.015			0.005			0.011
			(0.009)			(0.013)			(0.009)			(0.013)
Constant	1.437***	1.032***	4.242**	7.897***	7.488***	5.811**	1.604***	1.149***	2.636	8.014***	7.578***	4.631
	(0.093)	(0.384)	(1.867)	(0.159)	(0.542)	(2.767)	(0.107)	(0.433)	(1.846)	(0.159)	(0.545)	(2.922)
N	781	768	768	722	709	709	725	712	712	684	671	671
Pseudo-R^2/R^2	0.001	0.099	0.108	0.011	0.046	0.049	0.001	0.065	0.068	0.014	0.032	0.037

Note. Specifications 1–3 and 7–9 report the estimates of a probit regression on the likelihood of planting at least one tree. Specifications 4–6 and 10–12 present the results of an OLS regression with the number of trees planted conditional on planting at least one tree as the dependent variable. Robust standard errors are in parentheses. The restricted sample excludes those with weak environmental attitudes (specifications 7–12). Environmental attitudes were measured with six items on a numerical 5-point Likert scale. Weak pro-environmental attitudes are present if the mean is less than 3. The reference group for the FUTURE treatment is the PRESENT treatment. All other variables are explained in Table 2. Thirteen observations are omitted due to missing observations for income ($n = 11$) and political ideology ($n = 2$), which were non-required questions. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Regarding extensive margin effects, we run a probit regression model on the probability of planting at least one tree. Specifications 1–3 of Table 3 provide the corresponding estimates with and without controls for the main sample and specifications 7–9 for those who have strong environmental attitudes. The results show that the FUTURE treatment has no statistically significant effect on the probability of planting a tree. Considering the intensive margin, specifications 4–6 show a statistically significant increase in the number of trees planted conditional on planting at least one tree for participants in the FUTURE treatment compared to the PRESENT treatment. This finding is in line with Fig. 2 that shows considerable differences between the FUTURE and the PRESENT treatment for three and more trees planted. In addition, specifications 10–12 confirm the results of specifications 4–6 for participants with strong environmental attitudes, with the FUTURE treatment coefficient even larger. These findings suggest that the significant positive impact of future tense marking on the number of trees planted can be explained by intensive margin effects. Therefore, future tense marking could be particularly useful in increasing the intensity of desired pro-environmental behavior.

We expected self-reported pro-environmental intentions to be in line with actual behavior. Therefore, we consider behavioral intentions to be a secondary outcome of the study, and we examine whether different future-time referencing influences self-reported pro-environmental intentions. Interestingly, even if the mean scores for behavioral intentions are positively correlated with the number of trees planted ($r = 0.273$, $p < 0.001$), we find no statistically significant treatment differences with respect to pro-environmental intentions.[9] Table A1 in the Appendix provides estimates obtained from an OLS regression analysis, with the average pro-environmental intentions as the dependent variable. One explanation for this insignificant finding might be that the text in the first part of the experiment mentioned only the positive impact of tree planting to mitigate climate change, not the proposed actions that were

[9] In addition, based on Mann-Whitney rank-sum tests, we do not identify significant treatment differences in the mean of all behavioral intentions ($p = 0.910$), the four behavioral intentions formulated in the respective treatment tense ($p = 0.834$), or the five behavioral intentions formulated in a tense-neutral manner ($p = 0.943$).

used to elicit intentions (e.g., turning off lights or buying goods with less packaging). Thus, tree planting, which represents the behavioral outcome measure, may enable participants to easily make a direct link with climate change mitigation (Ajzen & Fishbein, 1975).

5. Potential mechanisms

In this section, we discuss construal level theory, timing precision, future orientation, and certainty of the occurrence of future climate events as potential mechanisms that might explain why using the future tense within a weak FTR language can affect individual pro-environmental behavior in the form of tree planting.

First, according to construal level theory, situations are perceived at different levels of abstractness, from concrete to abstract (Liberman & Trope, 2003; Trope & Liberman, 2010). Events that are psychologically perceived as further away are processed at a more abstract, higher level, while events that are psychologically perceived as close are processed at a more concrete, lower level (Trope & Liberman, 2010). The perception of psychological distance has four dimensions: temporal distance, social distance, spatial distance, and hypothetical distance. Individuals exposed to the future tense might perceive a greater temporal distance of future events such as climate change. Therefore, using the future tense may shift the processing of climate change to an abstract, higher construal level (Wang, Hurlstone, Leviston, Walker, & Lawrence, 2019). Construal level theory-based research argues that abstractness promotes long-term thinking and a focused, analytical mindset that facilitates decision-making for more abstract events (Fujita, Henderson, Eng, Trope, & Liberman, 2006; Liberman & Trope, 2008). Based on these considerations, individuals in the FUTURE treatment might tend to process information more abstractly and give analytical arguments more weight compared to individuals in the PRESENT treatment. The resulting greater problem awareness could lead to more pro-environmental behavior (Zhu et al., 2020). We measure the construal level of psychological temporal distance by surveying the response category width (RCW) in relation to the earliest and latest expected year of occurrence of irreversible consequences of climate change. Theoretically, abstract perceptions should be broad with a large confidence interval, and concrete perceptions should be specific with a narrow confidence interval (Krüger, Fiedler, Koch, & Alves, 2014). Specifically, we asked participants when they expected irreversible consequences of climate change at the earliest and at the latest. They were given a choice of 10 options (1 = today, 2 = from 2030, 3 = from 2040, 4 = from 2050, 5 = from 2060, 6 = from 2070, 7 = from 2080, 8 = from 2090, 9 = from 2090+, 10 = never). The value of the earliest occurrence of irreversible climate impacts is subtracted from the value given for the latest occurrence of irreversible climate impacts. A higher value (i.e., a higher range) corresponds to a higher construal level. In addition, we measure temporal distance to climate change with two items of a semantic differential-type scale (Brügger, Morton, & Dessai, 2016). Participants were asked to indicate how close or distant climate change felt to them on a 7-point scale (i.e., "very close" (1) to "very distant" (7); "like tomorrow" (1) to "like a thousand years away" (7)).

Second, grammatical marking of the future might lead participants to perceive future events as more precise in terms of timing (Zhu et al., 2020). The impact of climate change is associated with a high degree of uncertainty in the temporal dimension, which has also been shown to harm climate action (Jager, Janssen, & Vlek, 2002). Increasing timing precision could reduce uncertainty in the time dimension, which, in turn, might lead to more pro-environmental behavior. To measure timing precision, we also use the RCW. Note that reasoning based on construal level theory and timing precision is contradictory. The first mechanism assumes a broad RCW when grammatically marking the future, whereas the second mechanism assumes a narrow RCW. In addition, participants were asked how certain they were about the earliest date of irreversible climate-related consequences (0 = "completely uncertain" to 7 = "completely certain").

Third, using the future tense might increase future orientation (Zhu et al., 2020), which is associated with attaching greater importance to the future consequences of present actions (Joireman, 2005) and has been shown to be positively related to pro-environmental intentions (Gu et al., 2020) and behavior (Arnon & Carmi, 2014; Essl, Hauser, & von Bieberstein, 2022; Joireman, Van Lange, & Van Vugt, 2004). Consequently, if using the future tense activates future orientation, pro-environmental behavior might increase. We measured future orientation with a shortened (six items) validated German version of Kübel and Wittmann's (2020) future consequences scale. Participants were asked to indicate on a 7-point scale the extent to which statements about future and present considerations apply to them. For the statistical test, we took the average value of the six items.

Fourth, speaking about future events in the present tense might indicate a higher certainty of the occurrence of the future event (Ballweg, 1988). People might perceive the negative future consequences of climate change as more certain when they are expressed in the present tense. As a result, participants in the PRESENT treatment might have less hope of mitigating climate change and might perceive the effectiveness of mitigating climate change to be lower, leading to fewer planted trees. We measured certainty perception with the question regarding how much severe climate-related impacts can be mitigated in Central Europe (1 = "not at all" to 7 = "completely"). To measure mitigation perceptions, participants were asked how likely they thought it was that very severe, irreversible climate-related impacts would occur in Central Europe in the coming decades (1 = "extremely unlikely" to 7 = "extremely likely"). For the measurement of climate-related emotions, Steentjes et al. (2017) question was used: "When you think about climate change and all the things you associate with it: How strongly does that trigger the following emotions in you?" (1 = "not at all" to 7 = "very much"). We asked about the emotions hope, optimism, despair, fear, and discouragement.

To examine these four mechanisms, we conducted an online follow-up survey on Prolific. We retargeted all 781 participants who participated in the first study and met the criteria for the main analysis. Of these subjects, 460 (59%) participated in the follow-up study. The pre-registered exclusion criteria reduced the sample from 460 to 442 participants.[10] Identical to the first study, we manipulated the use of future-time referencing in the German language. The participants received the same climate change scenario and the same treatment as in the first study. In the PRESENT treatment ($n = 228$), subjects received a German description of the climate change scenario in the present tense, and in the FUTURE treatment ($n = 214$), the future tense was used to refer to future events. After reading the climate change scenario, the participants answered a survey that explored the proposed psychological mechanisms.

Table 4 presents the descriptive statistics for the four potential mechanisms and their constructs. To compare the treatments, we use two-sided Wilcoxon-Mann-Whitney tests. We identify no statistically significant differences between the two treatments for any of the proposed mechanisms. One reason for the null results might be the low response rate for the second study, as we collected data for only 56.6% of the participants in the first study. Notably, we find meaningful differences going in the proposed direction for the first proposed mechanism

[10] The study was pre-registered with the AEA RCT registry with the identifying number AEARCTR-0009132 and took place from March 28 to April 18, 2022. Participants' experiment sessions lasted, on average, 8 minutes, with a flat payment of GBP 0.75. In accordance with the pre-registered protocol, participants who completed the task within 2 minutes or less or not within 30 minutes of starting (n = 7), who failed crucial attention checks (n = 0), who did not answer the control question correctly the first time (n = 0), and who gave inconsistent answers to the question regarding the earliest and latest possible points in time of the occurrence of irreversible climate impacts (n = 13) were excluded.

Table 4
Descriptive statistics: psychological mechanisms.

Mechanisms	Constructs	Sample (n = 442)	FUTURE (n = 214)	PRESENT (n = 228)	FUTURE vs. PRESENT p values
Construal level theory	Response category width	1.63 (1.42)	1.72 (1.47)	1.54 (1.35)	0.215
	Temporal distance to climate change (1)	2.52 (1.45)	2.59 (1.43)	2.46 (1.47)	0.177
	Temporal distance to climate change (2)	2.33 (1.20)	2.35 (1.20)	2.32 (1.20)	0.784
Timing precision	Response category width	1.63 (1.42)	1.72 (1.47)	1.54 (1.35)	0.215
	Timing precision: certainty of starting point of response category width scale	4.29 (1.42)	4.21 (1.45)	4.36 (1.38)	0.189
Future orientation	Consideration of Future Consequences (CFC)	5.43 (0.84)	5.42 (0.85)	5.43 (0.84)	0.836
Certainty and hope regarding climate change	Extent of possible climate change mitigation	4.58 (1.09)	4.53 (1.08)	4.62 (1.11)	0.491
	Certainty of irreversible climate consequences	5.90 (1.12)	5.94 (1.08)	5.86 (1.16)	0.513
	Hope regarding climate change	2.21 (1.21)	2.21 (1.16)	2.21 (1.27)	0.528

Note. The table shows the means, standard deviations, and p values obtained from two-sided Wilcoxon-Mann-Whitney tests. Standard deviations are given in parentheses. Except for response category width, participants' answers were measured on a 7-point Likert scale. Response category width was measured on a 10-point scale ranging from 1 ("today") to 10 ("never").

based on construal level theory. As anticipated, the temporal distance to climate change is larger, and the RCW measuring the earliest and latest expected years of occurrence of irreversible consequences of climate change is broader in the FUTURE treatment than in the PRESENT treatment. However, neither of these differences is statistically significant. More research is needed to further analyze these and other potential psychological mechanisms.

6. Discussion and conclusion

This study examines whether there is a causal immediate effect of a language's future-time reference (present vs. future tense) on individual pro-environmental behavior in the form of tree planting. The linguistic-savings hypothesis suggests that languages in which speakers can refer to the future using the present tense lead to more future-oriented behavior than languages that separate the future from the present. Thus far, findings on the impact of future-time referencing in the environmental context are mixed. Although some studies find support for the linguistic-savings hypothesis (Kim & Filimonau, 2017; Liang et al., 2018; Mavisakalyan et al., 2018), others do not (Zhu et al., 2020).

The present study is the first to investigate the causal effect of a language's future-time reference on pro-environmental behavior by experimentally varying the use of the present and future tenses within the same language. Keeping the language constant enables cultural cues to be held constant. This allows us to focus solely on the effect of the grammatical structure on pro-environmental behavior. In this study, participants read a text using the present or future tense for future climate-related events, followed by an incentivized decision task about investing money in planting trees. Based on Chen's (2013) linguistic-savings hypothesis, participants in the PRESENT treatment should spend more money on planting trees than participants in the FUTURE treatment. We find the reverse effect: Participants in the FUTURE treatment planted statistically significantly more trees than those in the PRESENT treatment. The significant positive impact of future tense marking on the number of trees planted can be explained by intensive margin effects. Moreover, we aimed to uncover possible mechanisms behind the association between future-time reference and pro-environmental behavior. In an additional survey experiment, we find meaningful differences going in the proposed direction of construal level theory, however, none of these differences is statistically significant. Taken together, the findings of this study may provide important implications for environmental communication strategies in practice. The results suggest that future tense marking is a potential opportunity to effectively implement behavioral interventions and communication strategies in the environmental context. For example, policy makers and environmental organizations may promote pro-environmental behavior, in particular the intensity of it, by using the future tense to refer to the future impact of climate change.

More research is needed to support the effectiveness of future tense marking in fostering pro-environmental behavior. First, this study investigates the immediate impact of grammatical structure on pro-environmental behavior. Long-term exposure, however, might lead to different patterns of behavior. Chen's (2013) linguistic-savings hypothesis does not distinguish between short- and long-term exposure to language. Therefore, an important direction for future research is to examine how long-term exposure to differences in language structure affects pro-environmental behavior and future-oriented behavior in general. Second, more research is warranted to analyze the drivers behind our results. For example, an important direction for follow-up studies is to examine psychological distance, construal levels, and other potential underlying mechanisms more precisely. In addition, the way in which consequences are framed, either as gains or losses, may have an impact on environmental decisions (Ropret Homar & Knežević Cvelbar, 2021). Thus far, experimental studies on future-time referencing have used a gain-framing approach to consequences in intertemporal choice tasks (Angerer et al., 2021; Chen et al., 2019), whereas we used elements of loss and gain framing. The text on climate change consequences and tree planting emphasizes the future negative consequences of climate change and the positive consequences for the environment that result from participants' decisions to plant trees. Future research would benefit from investigating whether the effects of future-time referencing depend on the framing of future consequences. Another important question is whether the immediate impact of future-time referencing depends on the time horizon and the associated levels of certainty. Previous experimental studies on future-time referencing have focused on financial decisions with outcomes occurring at a specific point in the near future (1 to 12 weeks away; Angerer et al., 2021; Ayres et al., 2023; Chen et al., 2019). In contrast, in this study, we

are concerned with trees' absorption of carbon dioxide, an event that takes place at a distant and uncertain time in the future. Accordingly, the effect of future-time referencing may have different impacts in different domains due to issues related to the time horizon. Addressing the question of time horizon, a recent study by Kiss and Keller (2023) suggests that the usage of future tense increases as the future event gets farther away. This finding could explain why the linguistic-savings hypothesis might not be applicable to events further in the future, especially when both strong and weak FTR language speakers use the future tense for such distant events. Finally, we cannot rule out the possibility that the results of this study depend on the type of pro-environmental behavior and the language. Future studies could examine whether future marking is similarly effective for other types of pro-environmental behavior, as well as using other weak FTR languages.

Data availability

Raw data and statistical codes can be found under the following link: https://osf.io/49dzu/?view_only=8fa11e500cbd4de68385d7fcb0196260.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2023.102105.

Appendix

Additional analyses

Table A1
Effect of the FUTURE treatment on pro-environmental intentions: OLS regression.

	Main sample			Excl. weak environmental attitudes		
	Intentions (1)	Intentions (2)	Intentions (3)	Intentions (4)	Intentions (5)	Intentions (6)
FUTURE	–0.029	–0.033	–0.030	–0.032	–0.019	–0.014
	(0.074)	(0.072)	(0.073)	(0.072)	(0.071)	(0.072)
Female		0.392***	0.360***		0.348***	0.317***
		(0.075)	(0.076)		(0.075)	(0.076)
Age in years		0.022***	0.023***		0.021***	0.021***
		(0.004)	(0.006)		(0.004)	(0.005)
Income						
£10,000–£29,000		0.012	0.024		0.008	0.018
		(0.094)	(0.094)		(0.092)	(0.091)
£29,000–£59,000		–0.056	–0.060		–0.126	–0.140
		(0.103)	(0.104)		(0.102)	(0.104)
More than £60,000		–0.075	–0.067		–0.049	–0.047
		(0.120)	(0.120)		(0.117)	(0.118)
Education						
Vocational training		–0.127	–0.118		–0.113	–0.104
		(0.123)	(0.122)		(0.119)	(0.117)
Secondary school/high school and less		0.101	0.126		0.060	0.085
		(0.081)	(0.084)		(0.078)	(0.080)
Conservative ideology		–0.118***	–0.115***		–0.083***	–0.080***
		(0.024)	(0.024)		(0.024)	(0.025)
Non-German culture			0.058			0.130
			(0.143)			(0.151)
German proficiency			0.169**			0.199**
			(0.083)			(0.087)
German frequency			–0.058			–0.072
			(0.049)			(0.053)
Years in country of birth			–0.013			–0.010
			(0.011)			(0.011)
Years in country of residence			–0.002			–0.001
			(0.005)			(0.005)
Constant	4.946***	4.527***	3.663***	5.032***	4.552***	3.467***
	(0.051)	(0.173)	(0.904)	(0.050)	(0.166)	(0.929)
N	781	768	768	725	712	712
R^2	0.001	0.099	0.108	0.000	0.072	0.085

Note. The table presents OLS regression estimates. Robust standard errors are in parentheses. The dependent variable is the mean of all nine behavioral intentions asked, either for the main sample (specifications 1–3) or for the restricted sample that excluded those with weak environmental attitudes (specifications 4–6). Environmental attitudes were measured with six items on a numerical 5-point Likert scale. Weak pro-environmental attitudes are present if the mean is less than 3. The reference group for the FUTURE treatment is the PRESENT treatment. All other variables are as explained in Table 2. Thirteen observations are omitted due to missing observations for income ($n = 11$) and political ideology ($n = 2$), which were non-required questions. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

Analysis of the different samples

Table A2 shows the coefficients of the FUTURE treatment for Specification 1 of Model 1 from the main sample that includes previously excluded participants. First, we run an analysis that includes data for participants who did not believe in climate change and in the positive impact of planting trees. The results show that the significance level and the magnitude of the FUTURE treatment remains basically unchanged. When we restrict the sample to those who have strong environmental attitudes, the magnitude and statistical significance drop, but the effect remains statistically

significant at a 10% level. Next, we include data for those who indicated a native language other than German ($n = 823$). Including these subjects slightly weakens the significance level ($p<0.10$) and the magnitude of the FUTURE coefficient. This result suggests that a large internalized familiarity with the German language might be a prerequisite for the treatment effect. The results of specifications 2 and 3 of Model 1 are also robust except for specification 3, when climate change and tree skeptics are included (the statistical significance level of the FUTURE coefficient drops to $p = 0.103$).

Table A2
Analysis of different samples for Specification 1 of Model 1.

	Main sample	Including climate change and tree skeptics	Including non-German native language
Number of trees	0.568**	0.524**	0.467*
	(0.253)	(0.255)	(0.248)
	n = 781	n = 805	n = 823
Number of trees excluding weak environmental attitudes	0.589**	0.478*	0.480**
	(0.247)	(0.250)	(0.243)
	n = 725	n = 736	n = 765

Note. The table displays the coefficients of the FUTURE treatment of Specification 1 of Model 1 for the main sample and the different sub-samples. The baseline group for the FUTURE treatment is the PRESENT group. The dependent variable is the number of trees planted. Robust standard errors are shown in parentheses. In addition, the table displays FUTURE treatment coefficients without participants with weak environmental attitudes. The main sample is the sample used after participants were excluded according to the pre-registered protocol. The sample that included climate change and tree skeptics incorporates participants who did not believe in climate change and/or the positive impact of planting trees as climate change mitigation measure ($n = 6$). The third sample includes participants who did not speak German as their native language. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

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