

The effect of future-tense referencing on pro-environmental behavior

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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 possible negative future impacts of climate change written in either the present or future tense. Subsequently, we measured pro-environmental behavior using an incentivized task that represents a trade-off between individual short-term financial rewards and long-term environmental gains. The results reveal a positive effect of future tense marking on pro-environmental behavior. We discuss potential mechanisms that explain why future-time referencing might affect individual pro-environmental behavior.

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

JEL Codes: C91, D90, Q50

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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 et al., 2021; Goldstein et al., 2008). All of these interventions are communicated via language. What if language inherently also has an immediate influence on pro-environmental behavior? Language as a means of influencing pro-environmental behavior needs to be better understood to optimize existing interventions and create new ones.

This study joins a growing body of economic literature that examines how language influences individual decision-making (Chen, 2013; He et al., 2020; Lien & Zhang, 2020; Xing, 2021). 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 into “It rains tomorrow”. However, they can also use the future tense “Morgen wird es regnen”, which translates into “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). The evidence in line with this argument comes from different areas, such as saving rates (Chen, 2013), patience (Falk et al., 2018; Sutter et al., 2018), and pro-environmental policy support (Pérez & Tavits, 2017). In contrast, Zhu et al. (2020) find reverse results regarding concern with climate change and engagement in more climate action.

The majority of these studies on language structure are based on correlations using existing survey data (Chen, 2013; Mavisakalyan et al., 2018). Although these studies offer important insights, they do not allow us to make inferences about the causality of the effect of future-time referencing on individual behavior. Therefore, experimental variation in the way the future is referenced within a given language is proposed to draw conclusions about the causal trigger. Chen et al. (2019) and Angerer et al. (2021) tested the linguistic-savings hypothesis in a controlled experimental setting. Both studies chose languages that allow to refer to future events using present or future tense and thus hold cultural cues constant. These studies found no causal effect of future marking on patience. Similar experiments are needed with regard to pro-environmental behavior, where it is not yet clear whether the effect of language on pro-environmental behavior is due to the language's future marking or the culture embedded within the language. Furthermore, because the findings regarding the language structure in the environmental context are mixed, it is unclear whether weak FTR promotes or weakens pro-environmental behavior.

This study examines whether a language's future-time reference has a causal effect on individual pro-environmental behavior. We conducted a between-subject online experiment within a language that allows weak FTR and strong FTR (i.e., the German language). The participants were randomly assigned to either the FUTURE (German with future tense marking, $n = 383$) or the PRESENT (German with present tense marking, $n = 398$) treatment. Next, the participants read a climate change scenario in their assigned future-time referencing condition. Participants' pro-environmental behavior was elicited by using a recently developed incentivized decision task (Essl et al., 2022). 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. We discuss four potential psychological mechanisms behind this result. In an online follow-up survey retargeting the subjects of the first study ($n = 442$), we test these mechanisms. We find no statistically significant differences between the two treatments for any of the proposed mechanisms, which could be due to the low

response rate (56.6% of the participants in the first study). Only for one of the four mechanisms, construal level theory, do we find meaningful differences going in the predicted direction. According to construal level theory, events that are psychologically perceived as more distant from oneself 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 on more abstract events like climate change (Liberman & Trope, 2008).

The present paper is the first to investigate the causal effect of a language's future-time reference on pro-environmental behavior within the same language. This allows us to focus on the effect of the grammatical structure on pro-environmental behavior, independent of possible cultural cues. This study makes four contributions to the literature. First, it addresses the need for more experimental research with regard to the effect of future marking on pro-environmental behavior. By holding the language constant, we show that future marking can have a positive effect on pro-environmental behavior. Therefore, this research is particularly relevant for more effective behavioral interventions and communication strategies to foster pro-environmental behavior. Second, we contribute to research that systematically examines the linguistic-savings hypothesis in different areas. The influence of this hypothesis on patience has been investigated experimentally (Angerer et al., 2021; Chen et al., 2019), and similar studies in other domains are desirable. Third, the paper sheds some initial light on possible underlying mechanisms that can explain why using the future tense within a weak FTR language (German) might affect individual pro-environmental behavior. Although not statistically significant, the results suggest that strong FTR leads to an understanding of environmental issues at a higher construal level. This result opens up avenues for further research investigating the channels that promote pro-environmental behavior through future marking. Fourth, we contribute to filling the gap in the measurement of pro-environmental behavior with a consequential environmental decision task. While previous environmental research examining the linguistic structure was based on self-reported behavior, we used an incentivized environmental decision task.

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: It 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 Chinese, do not require the future to be marked (Chen, 2013; Dahl & Velupillai, 2011). 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 et al., 2002; Ramsey, 1928; Solnick et al., 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 for intertemporal preferences (Chen, 2013). Specifically, 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 and may make people feel that the future is temporally closer to the present. Thus, people behave more patiently.

Several correlational studies support the linguistic-savings hypothesis. People who speak a strong FTR language are less patient (Falk et al., 2018; Sutter et al., 2018), smoke more, are more obese, exercise less, and practice safer sex less often (Chen, 2013). Similar patterns have been shown to explain pro-environmental actions (Mavisakalyan et al., 2018), policy support (Pérez & Tavits, 2017), savings targets (Guin, 2016), patience (Ayres et al., 2020; Herz et al., 2021; Sutter et al., 2018), and corporations' future-oriented behaviors (Kim & Filimonau, 2017; Liang et al., 2018). These studies are based on cross-country or cross-cultural correlative comparisons

with survey data (Chen, 2013; Guin, 2016), they do not experimentally vary the language (Herz et al., 2021; Sutter et al., 2018), or the sample is potentially biased due to attrition and selection bias (Ayres et al., 2020). In such settings, no causal conclusion can be drawn about the trigger of the relationship between language structure and time preferences, as the observed association could be due to either the grammatical marking of the future tense (i.e., in line with the linguistic-savings hypothesis) or unobserved cultural traits correlating with the language. In fact, a large strand of economic literature uses language as a proxy for culture (Alesina & Ferrara, 2005; Desmet et al., 2012; Hübner & Vannoorenberghe, 2015).

Experimental studies are suited to investigate the causal effect of strong FTR vs. weak FTR on future-oriented behavior (Roberts et al., 2015). Chen et al. (2019) and Angerer et al. (2021) test the linguistic-savings hypothesis in a controlled experimental setting by taking advantage of weak FTR languages, that is, languages that can refer to the future using the present tense and the future tense. By keeping the language constant, these studies hold cultural cues constant, which might causally influence time preferences. Within the Chinese language, Chen et al. (2019) manipulate the use of “will” in the description of the rewards in a standard time preference task and find no causal effect of language on intertemporal choice. Angerer et al. (2021) replicate these results for the German language and also find no significant difference due to the grammatical tense distinction.

2.2 Future-time referencing and pro-environmental behavior

Further investigation of future-time referencing is particularly relevant for pro-environmental behavior, as it is an important area of future-oriented behavior, typically 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 languages that grammatically separate the future and the present have an influence on pro-environmental decision-making. Thus far, findings regarding language structure in the environmental context are mixed. In line with the linguistic-savings hypothesis, several studies have suggested that speakers of a weak FTR language are more likely to adopt environmentally responsible behavior (Mavisakalyan et al., 2018), to support policies to prevent environmental damage (Pérez & Tavits, 2017), and to have higher pro-environmental attitudes (Kim & Filimonau, 2017). In

addition, Liang et al. (2018) show that companies with a weak FTR language as their official language are more involved in corporate social responsibility activities. In contrast, Zhu et al. (2020) indicate that countries with a higher percentage of speakers of strong FTR languages are more concerned with climate change and engage in more climate action. They 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 toward climate change, consequently leading to more pro-environmental behavior.

Most environmental research on language structure is correlational. An exception is Pérez and Tavits (2017), who randomly assign the interview language to Estonian (weak FTR language) or Russian (strong FTR language) bilinguals. They find that respondents who were interviewed in Estonian are 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 testing the causal effect of language structure on pro-environmental behavior in a controlled experimental setting with native German speakers. Specifically, we create exogenous variation in the language structure by making use of the linguistic features of the German language, in which speakers can decide to use the future or present tense for future events. One important advantage of this approach is that, by distinguishing only between use of the present tense and the future tense, cultural cues can be held constant, allowing us to investigate whether the grammatical structure has an effect on pro-environmental behavior. Furthermore, this approach prevents attrition and selection bias. In contrast, experimental variation or assignment of language may lead to the language preferences of bilingual participants (Ayres et al., 2020). In addition, previous environmental studies investigating the effect of the language structure have in common that they use non-incentivized, self-reported constructs. We aim to experimentally clarify whether there is an instantaneous causal effect of future tense marking on actual pro-environmental behavior measured with an incentivized environmental decision task. Measuring actual behavior is important because self-reports offer important insights, but entail the risk of overestimating actual behavior and can be influenced by other factors (Clements et al., 2015). People can be affected by poor memory and reporting biases when reporting their own behavior (Gifford, 2014; Kormos & Gifford, 2014).

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 a language's future marking on individual pro-environmental behavior within a language (in our case, German) that allows weak and strong FTR. The study was pre-registered on the platform of the American Economic Association's (AEA's) registry for randomized controlled trials (AEARCTR-0008477) and obtained 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 applied 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 either in the present tense (e.g., «Die Klimakrise hat in den nächsten Jahrzehnten zunehmend negative Auswirkungen.») or in 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 Figure 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. (2022). The *Tree Task* is an incentivized decision task used to measure participants' behavior toward the environment. Participants received an endowment of GBP 0.86 (about USD 1.15) and

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 to English): "The climate crisis will have an increasingly negative impact in the coming decades."

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 can 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 short-term 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, i.e., plant zero (= GBP 0) to 10 (= GBP 0.86) trees. For each option, we provided the consequences in terms of money investment, carbon dioxide absorption in kilograms, and carbon dioxide compensation translated into car kilometers (see online supplementary material). To describe the future consequences of the different *Tree Task* options provided, the present tense was used in the PRESENT treatment group and the future tense in the FUTURE treatment group. The kinds of future referencing used in the PRESENT and FUTURE treatments differed in a total of 58 places across the first and second parts. 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.

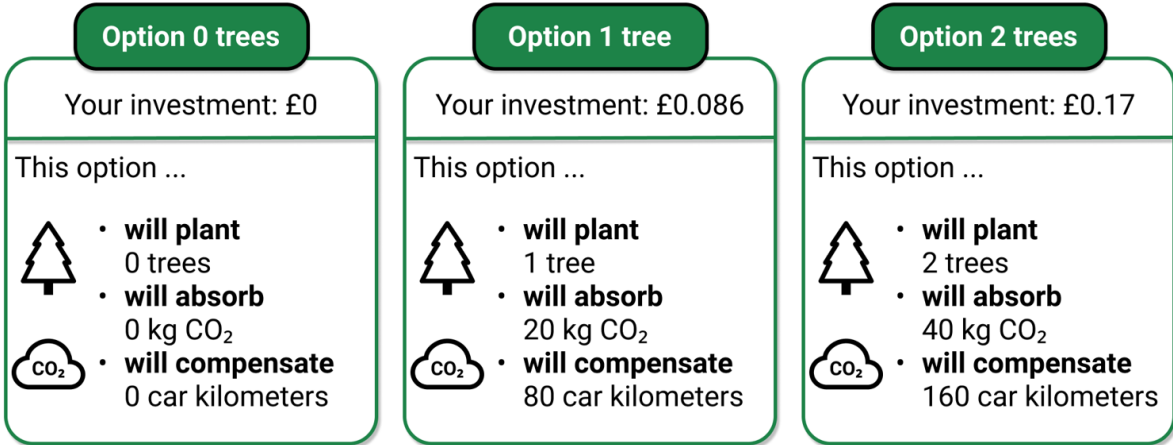


Figure 1: Excerpt from the display of the options of the Tree Task in the FUTURE treatment (translated into English)

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 et al., 2019), general environmental views (ISSP Research Group,

2012), and language-related and demographic questions. More specifically, behavioral intentions were measured by describing nine different behavioral intentions with regard to 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.³ 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) 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 experiment was conducted online on the crowdsourcing platform Prolific⁴ from November 11 to November 26, 2021. Experimental sessions lasted, on average, 16 minutes, with a flat payment of GBP 1.24 per participant. The mean additional payment for the *Tree Task* was GBP 0.23 (range: GBP 0 to 0.86, SD = 0.32). 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). In total, 877 people

³ 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.

⁴ Prolific is an established crowd working online platform (Palan & Schitter, 2018).

participated in the experiment. In accordance with the pre-registered protocol, participants were excluded who did not complete the Prolific task within 60 minutes 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 ($n = 46$).⁵ The exclusion criteria reduced the main sample to 781 subjects (53% female; mean age: 28 years, $SD = 9.36$), out of whom 383 received the FUTURE treatment and 398 received the PRESENT treatment. The randomization between the two treatment groups was successful for all considered variables, except the number of years lived in the country of birth.⁶ Table 2 in the Appendix provides descriptive statistics for the sociodemographic variables and environmental attitudes for the main sample and the treatment groups separately.

4 Results

4.1 Impact of strong vs. weak FTR on pro-environmental behavior

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 a Mann-Whitney rank sum test,⁷ and contrary to the linguistic-savings hypothesis, participants in the FUTURE treatment planted statistically significantly more trees than those in the PRESENT treatment ($p = 0.008$). To examine the stability of the treatment effects, we estimate the following OLS regression model

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

where the dependent variable y_i is the number of planted trees by individual i . The indicator $FUTURE_i$ 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 further estimated model specifications where we control for sociodemographic X_i and culture

⁵ 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 Appendix, we present the robustness of the results by including some of these participants.

⁶ We control for the variable years in birth country in the regression analysis.

⁷ All statistical tests are two-sided.

and language-related variables C_i . ε_i is the idiosyncratic error term. In all model specifications, we estimated robust standard errors.

Table 1: Effect of the FUTURE treatment on the number of planted trees: 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** (0.253) | 0.504** (0.249) | 0.483* (0.252) | 0.589** (0.247) | 0.569** (0.249) | 0.536** (0.251) |
| Female | | 1.166*** (0.262) | 1.191*** (0.271) | | 0.958*** (0.265) | 0.941*** (0.274) |
| Age in years | | 0.047*** (0.013) | 0.034** (0.016) | | 0.037*** (0.013) | 0.023 (0.016) |
| Income >= 60'000 GBP | | 0.282 (0.372) | 0.263 (0.376) | | 0.298 (0.368) | 0.275 (0.372) |
| Conservative ideology | | -0.390*** (0.087) | -0.393*** (0.087) | | -0.212** (0.092) | -0.213** (0.092) |
| Non-German Culture | | | -0.503 (0.464) | | | -0.191 (0.463) |
| German Proficiency | | | -0.124 (0.268) | | | 0.181 (0.278) |
| German Frequency | | | -0.034 (0.159) | | | -0.056 (0.175) |
| Years in Birth Country | | | 0.005 (0.047) | | | 0.027 (0.047) |
| Years in Country of Residence | | | 0.016 (0.014) | | | 0.017 (0.015) |
| Constant | 7.302*** (0.180) | 6.710*** (0.529) | 8.187*** (2.987) | 7.579*** (0.178) | 6.694*** (0.532) | 5.040 (3.096) |
| N | 781 | 768 | 768 | 725 | 712 | 712 |
| R-squared | 0.006 | 0.075 | 0.079 | 0.008 | 0.042 | 0.045 |

Note. The table presents ordinary least squares estimates. Robust standard errors are in parentheses. The dependent variable is the number of planted trees, 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 taking a value of 1 for women and 0 for men and non-binary and other individuals. Income is a binary variable taking the value 1 for an income higher than GBP 60,000 and 0 otherwise. Conservative ideology is measured on a 10-point scale ranging from 1 (completely left/liberal) to 10 (completely right/conservative). Non-German Culture is a binary variable taking 1 for 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) (non-required questions). *, **, and *** document significance at the 10%, 5%, and 1% levels, respectively.

Table 1 presents the regression results. All specifications show a statistically significant positive effect of the FUTURE treatment on the number of planted trees. Specification 1 contains the overall treatment effect, as shown by the descriptive statistics. Participants in the FUTURE treatment group plant 0.56 more trees compared to participants in the PRESENT treatment group. The magnitude and significance level of the treatment effect remains stable when we control for sociodemographic variables (Specification 2) as well as for culture and language-related variables (Specification 3). In addition to the statistically significant FUTURE treatment effect, gender and age

have a statistically significant impact on the number of planted trees, with women and older people planting more trees. Furthermore, a stronger conservative ideology leads to significantly fewer planted trees. In contrast, 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 weak and strong FTR have different effects on the pro-environmental behavior of 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 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.

We expected self-reported pro-environmental intentions to be in line with actual behavior. Therefore, we consider behavioral intentions a secondary outcome of the study, and we examine whether different future-time referencing influences self-reported pro-environmental intentions. Interestingly, even if mean scores on behavioral intentions are positively correlated with the number of planted trees ($r = 0.273$, $p = 0.000$), we find no statistically significant treatment differences with respect to pro-environmental intentions.⁸ One explanation for this finding might be that the text in the first part of the experiment mentions only the positive impact of tree planting to mitigate climate change, not the proposed actions that were used to elicit intentions (e.g., turning off lights or buying goods with less packaging material). Thus, tree planting, which represents the behavioral outcome measure, may enable participants to easily make a direct link to climate change mitigation (Ajzen & Fishbein, 1975).

⁸ See Table 3 in the Appendix for estimates obtained from an OLS regression analysis (following Model 1) with the average pro-environmental intentions as the dependent variable. 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 ($p = 0.943$).

5 Potential mechanisms

In the following section, we discuss four potential mechanisms that could explain why using the future tense within a weak FTR language (German) might affect individual pro-environmental behavior. First, construal level theory suggests that events that are psychologically perceived as more distant from oneself are processed at a more abstract level. Abstractness promotes long-term thinking and a focused, analytical mindset that facilitates decision-making on more abstract events like climate change (Liberman & Trope, 2008). Using the future tense may shift the processing of climate change to a higher construal level because individuals exposed to the future tense might perceive a greater temporal distance of future consequences of climate change (Wang et al., 2019). Compared to individuals in the PRESENT treatment, those in the FUTURE treatment might tend to process information more abstractly and give analytical arguments more weight (Trope & Liberman, 2010). The resulting greater problem awareness could lead to more pro-environmental behavior (Zhu et al., 2020).

Second, grammatical marking of the future might make future events perceived as more precise in terms of timing (Zhu et al., 2020). As the impact of climate change is associated with a high degree of uncertainty in the temporal dimension, which is shown to harm climate action (Jager et al., 2002), increasing timing precision may lead to more pro-environmental behavior. Note that the first and second mechanisms contradict each other: The first mechanism assumes a broad time period when grammatically marking the future, whereas the second mechanism assumes a narrow, and thus more precise, time period.

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 et al., 2022; Joireman et al., 2004). Consequently, if the confrontation with the future tense activates future orientation, pro-environmental behavior might increase.

Finally, in the German language, speaking about future events in the present tense might indicate higher certainty (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 less pro-environmental behavior.

To examine these four mechanisms in more detail, we conducted an online follow-up survey on Prolific, a crowdsourcing platform. We retargeted all 781 participants who participated in the first study and fulfilled the criteria for the main analysis. Of these participants, 460 (59%) took part in the follow-up study. The pre-registered exclusion criteria reduced the sample from 460 to 442 participants.⁹ Identical to the first study, we manipulated the use of future-time referencing in the German language. 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.

We identify no statistically significant differences between the two treatments for any of the proposed mechanisms (see the online supplementary material for the exact measurement of each mechanism and the results). One reason might be the low response rate for the second study, as we have 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 mechanism, construal level theory. As proposed, the psychological distance to climate change is larger, and the response category width measuring the earliest and latest expected year 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 ($p = 0.177$ and $p = 0.215$, Wilcoxon-Mann-Whitney tests).

⁹ 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 were excluded 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 ($n = 13$).

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. Thus far, findings on the impact of the language structure in the environmental context are mixed. Whereas some studies find support for the linguistic-savings hypothesis (Kim & Filimonau, 2017; Liang et al., 2018; Mavisakalyan et al., 2018), others find reverse behavior (Zhu et al., 2020). The present study is the first in the environmental context to experimentally vary the use of present and future marking within the same language. This allows us to keep cultural cues constant, thus focusing solely on the effect of the grammatical structure on pro-environmental behavior. In this study, participants read a text using present or future marking 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. In contrast to this hypothesis, we find the reverse effect: Participants in the FUTURE treatment planted statistically significantly more trees than those in the PRESENT treatment. Construal level theory offers a potential explanation for these results (Trope & Liberman, 2010). In terms of pro-environmental intentions, there are no significant differences between the treatments; however, pro-environmental intentions correlate strongly with the number of planted trees. The findings of this study are relevant for policy makers and environmental organizations, which can promote pro-environmental behavior by using the future tense to refer to the future impact of climate change.

Some limitations of the study offer interesting avenues for future research. 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. In addition, future research could try to replicate the effect of future marking on pro-environmental behavior in other languages that offer present and future marking for future events. In this context, more research is warranted to incorporate the measurement of

psychological distance and construal levels, as well as other potential psychological mechanisms. Finally, we cannot rule out the possibility that the results of this study depend on the way pro-environmental environmental behavior is measured. Future studies could examine whether future marking is similarly effective for other types of pro-environmental behavior. Eventually, these approaches will lead to further clarification of the causal effect of future tense marking on pro-environmental behavior.

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Appendix

Additional Analysis

Table 2: Sample characteristics and randomization check

| | Sample (n=781) | FUTURE (n=383) | PRESENT (n=398) | FUTURE vs. PRESENT p-values |
|---|-------------------|-------------------|--------------------|-----------------------------------|
| <i>Demographics</i> | | | | |
| Gender (% female) | 52.75 | 54.05 | 51.51 | 0.477 |
| Age in years | 28.03 (9.36) | 27.80 (8.74) | 28.30 (9.92) | 0.974 |
| Conservative ideology | 3.48 (1.64) | 3.41 (1.62) | 3.54 (1.66) | 0.268 |
| Culture (% German culture) | 91.17 | 91.64 | 90.70 | 0.643 |
| Income (% earn more than 60'000 GBP) | 15.32 | 15.08 | 15.56 | 0.853 |
| Years in birth country | 17.41 (2.73) | 17.58 (2.32) | 17.26 (3.07) | 0.004 |
| Years in country of residence | 24.52 (11.02) | 24.80 (10.47) | 24.24 (11.53) | 0.196 |
| <i>Language related variables</i> | | | | |
| German proficiency | 9.78 (0.50) | 9.80 (0.52) | 9.77 (0.49) | 0.167 |
| German frequency | 9.78 (0.73) | 9.77 (0.75) | 9.78 (0.71) | 0.579 |
| <i>Climate Change related variables</i> | | | | |
| Pro-environmental attitudes | 3.99 (0.66) | 4.02 (0.65) | 3.96 (0.67) | 0.178 |

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 Chi2-test. For continuous variables, the p -value were obtained from Wilcoxon-Mann-Whitney tests.

Table 3: 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 (0.074) | -0.039 (0.073) | -0.037 (0.072) | -0.032 (0.072) | -0.027 (0.071) | -0.020 (0.071) |
| Female | | 0.402*** (0.075) | 0.377*** (0.076) | | 0.353*** (0.075) | 0.328*** (0.076) |
| Age in years | | 0.018*** (0.004) | 0.020*** (0.005) | | 0.018*** (0.004) | 0.018*** (0.005) |
| Income >= 60'000 GBP | | -0.058 (0.101) | -0.052 (0.102) | | -0.002 (0.099) | 0.002 (0.100) |
| Conservative ideology | | -0.122*** (0.023) | -0.121*** (0.024) | | -0.089*** (0.024) | -0.087*** (0.024) |
| Non-German Culture | | | 0.068 (0.142) | | | 0.133 (0.149) |
| German Proficiency | | | 0.143* (0.081) | | | 0.173** (0.086) |
| German Frequency | | | -0.064 (0.049) | | | -0.073 (0.052) |
| Years in Birth Country | | | -0.013 (0.011) | | | -0.010 (0.012) |
| Years in Country of Residence | | | -0.003 (0.005) | | | -0.002 (0.005) |
| Constant | 4.946*** (0.051) | 4.646*** (0.152) | 4.114*** (0.856) | 5.032*** (0.050) | 4.630*** (0.152) | 3.833*** (0.891) |
| Observations | 781 | 768 | 768 | 725 | 712 | 712 |
| R-squared | 0.000 | 0.094 | 0.102 | 0.000 | 0.066 | 0.078 |

Note. The table presents ordinary least squares 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 excluding those with weak environmental attitudes (Specifications 4-6). Environmental attitudes were measured with 6 items on a numerical 5-point Likert scale. Weak pro-environmental attitudes are present if the mean is less than 3. Reference group to the FUTURE treatment is the PRESENT treatment. Female is a binary variable taking the value 1 for females and 0 for males and non-binary & other individuals. Income is a binary variable taking the value 1 for an income higher than 60'000 GBP and 0 otherwise. Conservative ideology is measured on a 10-point scale ranging from 1 (completely left / liberal) to 10 (completely right / conservative). Non-German Culture is a binary variable taking 1 for 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). 13 observations are omitted due to missing observations for income (n=11) and political ideology (n=2) (non-required questions). *, **, and *** document significance at the 10%, 5%, and 1% levels.

Analysis of the different samples

Table 4 shows the coefficients of the FUTURE treatment for Specification 1 of Model 1 from our main sample and when including formerly excluded participants. First, we run an analysis including data of those participants who do 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 restricting the sample to those who have strong environmental attitudes, the magnitude and statistical significance drop, but the effect stays statistically significant at a 10% level. Next, we additionally include data of those who indicated another mother tongue 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 Specification 2 and 3 of Model 1 are also robust except for Specification 3 when climate change and tree sceptics are included (the statistical significance level of the FUTURE coefficient drops to $p = 0.103$).

Table 4: Analysis of different samples for Specification 1 of Model 1

| | Main sample | Incl. climate change and tree sceptics | Incl. Non-German mother tongue |
|--|-------------------------------|--|--------------------------------|
| No. trees | 0.568** (0.253) n = 781 | 0.524** (0.255) n = 805 | 0.467* (0.248) n = 823 |
| No. trees excl. weak environmental attitudes | 0.589** (0.247) n = 725 | 0.478* (0.250) n = 736 | 0.480** (0.243) n = 765 |

Notes: The table displays the coefficients of the FUTURE treatment of Specification 1 of Model 1 for the main sample and different sub-samples. Baseline group for the FUTURE treatment is the PRESENT group. The dependent variable is the number of planted trees. Robust standard errors are shown in parentheses. In addition, the table displays FUTURE treatment coefficients excluding participants with weak environmental attitudes. The main sample is the sample used after the exclusion of participants according to the pre-registered protocol. The sample that includes climate change and tree sceptics incorporates participants who do 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 do not have German as mother tongue. *, **, 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 "The effect of future-tense referencing on pro-environmental behavior" by Andrea Essl, Manuel Suter, and Frauke von Bieberstein can be found under the following link:

https://osf.io/49dzu/?view_only=8fa11e500cbd4de68385d7fcb0196260