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Projection bias in environmental beliefs and behavioural intentions - An application to solar panels and eco-friendly transport

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ABSTRACT

The projection bias corresponds to the human tendency to project current preferences into the future as if present preferences will remain unchanged, omitting a range of external influences over the current preferences. We design a survey experiment to investigate the projection bias relevance on two environmentally friendly initiatives, namely solar panels and eco-friendly transport. We found that beliefs and behavioral intentions are subject to positive change when individuals are solicited a day when the weather is congruent with the proposed changes. We draw several policy and managerial implications for environmental issues.

1. Introduction

People frequently exhibit biases that make their decisions appearing as irrational, by taking suboptimal decisions but in a predictable way (Ariely, 2008). For instance, many people think that their current beliefs or intentions will remain the same in the future, albeit they are influenced by incidental and irrelevant information. Going to the grocery store and being very hungry frequently result in higher purchases of junk food and higher willingness to pay, even if the consumption is scheduled later (Loewenstein et al., 2003; Briz et al., 2015; de-Magistris and Gracia, 2016). Blasch and Daminato (2020) show that status quo biased people, who exhibit a preference for the current state, refrain from replacing their old household appliances. We propose projection bias as a complementary rationale that can explain why household owners (or tenants) keep their habits and appliances. People's predictions about future preferences are frequently shaped by their current preferences, that are subject to several influential factors such as social pressure, the way in which the issue is framed or the weather at the administration time (see e.g., Murray et al., 2010). This tendency to project the present preferences into the future leads to predictions that are present-biased. Gilbert et al. (2002) described this bias as presentism and defined it as a "tendency to over-estimate the extent to which [people's] future experience of an event will resemble their current experience of an event." Even in the cases of important economic decisions, empirical evidence supports that people succumb to the projection bias (Conlin et al., 2007; Busse et al., 2013; Busse et al., 2015; Acland and Levy, 2015). Bauckham et al. (2019) show that this presentism bias is attenuated when "thinking about the preferences of other people". Moreover, the intensity of the bias depends on the difference between individuals' true future and their actual preferences (Loewenstein et al., 2003).

In this work, we are particularly interested in investigating the extent to which the projection bias may impact decisions in the environmental realm. We selected two decisions which are known to be weather dependent, namely the adoption of solar panel and the use of eco-friendly transport (e.g., biking, walking or public transportation), to see if the weather at the time of the survey will impact future intentions. Purchasing solar panels vs. changing transportation mode involve different kinds of efforts and dimensions (e.g., money-related efforts versus convenience related efforts, non-physical efforts versus physical efforts, quasi-irreversible versus highly reversible, low social visibility versus high and recurrent social visibility, already practiced or adopted versus considered in the future).

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Following this line of inquiry, we test the projection bias in the environmental domain by examining whether it is likely to influence environment-related beliefs and behavioral intentions. A survey on people's opinions about the reality of climate change revealed that public support to undertake ambitious efforts can be over-influenced by the weather at the administration time (Egan and Mullin, 2012). Climate change issues are clearly related to future consequences of current choices. The projection bias describes the tendency to project one's current values and preferences into the future, as if the future self will correspond to the current one. A better understanding of how this bias impacts today's energy and climate change-related decisions can be leveraged to facilitate pro-environmental decisions and behaviors that will serve climate change mitigation. This "experience-perception link" is likely to grow in case of floods or other extreme events, affect beliefs about climate change and intentions to take action, and can be exploited strategically by various stakeholders and influencers (e.g., weather-based marketing) (see Murray et al., 2010; Zwebner et al., 2013; Bergquist et al., 2019). Evaluating the willingness to pay for natural amenities such as quietness and calmness (see Navrud, 2002) can be overly influenced by days where noise pollution is high even if this situation is non-recurring (e.g. road works). Similarly, power interruptions could unduly influence adoption or willingness-to-pay for alternative sources of energy that are less subject to the current power outage. If empirically supported, influencers can shape outcomes in favor of their agenda, by exploiting certain opportunity windows. The relevance of the projection bias in the environmental realm is considerable, given the large range of behaviors that can be influenced and the likely ratchet effect. The ratchet effect corresponds to situations that cannot be reversed once a specific step has been completed such as installing solar panels for example. Using weather to encourage pro-environmental choices constitutes a low cost nudge, if scaled up, and could potentially deliver impressive results.

Our study aims at examining whether the weather at the administration time would influence the responses of participants to a questionnaire addressing two ecological actions, namely 1) beliefs and purchase intention related to solar panels and 2) beliefs regarding the importance of adopting environmentally-friendly transport to preserve the environment and their intention to use them. We run an experiment based on a survey that remains perfectly identical, except that it is administered either on a rainy or sunny day as reported by the local weather bulletin (and confirmed by the research assistants who administered the survey).

2. Conceptual framework and main hypotheses

The rational choice theory is a mainstream approach that has substantially influenced energy policy making, but it tends to ignore the fact that people do not always take decisions in a 'rational' way, but their beliefs, values and experiences are also important in influencing their decisions. In turn, these cognitive or experiential types of values can be influenced by contextual factors like the weather (e.g., Conlin et al., 2007; Simonsohn, 2010; Busse et al., 2013). Understanding the role of projection bias offers prospect for mitigating this pitfall of rational choice theory and gives a better understanding of human behaviour with regards to preferences. A possible explanation of projection bias is the false assumption that one's own current beliefs and behavioral intentions are accurate, shared by all and will be also shared by his/her future self (Loewenstein et al., 2003). For example, people frequently under-appreciate habit formation and hedonic adaptation[1] in case of traumatic events (Loewenstein et al., 2003).

Using data on catalog orders of cold-weather items, Conlin et al. (2007) found evidence that people's decisions are over influenced by the current weather. Busse et al. (2013, 2015) showed that a warm weather led people to buy a disproportionate number of convertibles and homes with swimming pools (see also Simonsohn, 2010 about college enrollment). Further, this literature also brings support to the existence of a projection bias in various high stake investment decisions, such as housing. More recently, Buchheim and Kolaska (2017) found that advance sales of an outdoor movie theater were caused by weather conditions at the time of purchase even though the latter was irrelevant for the experience of visiting the theater in the future. In the environmental realm, Chang et al. (2018) found that daily air pollution levels have a significant effect on the decision to purchase or cancel health insurance in a manner inconsistent with predictions of rational choice theory but consistent with those generated by the projection bias and salience literature. More precisely, a one standard deviation increase in daily air pollution leads to a 7.2% increase in the number of insurance contracts sold that particular day. Solar panels, a technology highly relying on the weather, reveals similar patterns. When choosing to adopt solar panels, the rational agent should consider the sunshine rate over the long-term without devoting attention to the weather at the survey time. However, some studies found that people's decision to adopt solar panel may be disproportionally impacted by the current weather, meaning that individuals' expectation about future weather is over-influenced by their current experience of sunshine or rain. Lamp (2018) tested for the effect of weather on solar technology adoption and showed that a one standard deviation increase in monthly sunshine hours above the long-term average leads to an approximate 6.2% growth in the residential solar market over a six-month period. He found strong support for the projection bias explanation. Similarly, Liao (2020) suggested that short-run weather conditions affect customers' valuation for solar panels and showed that Californian customers having signed up for solar panels are more likely to cancel their contracts when they experience bad weather conditions the days following the signature. In contrast, non-residential customers are not subject to the same effect.

In addition to intuitive evidence that biking (or walking) are more appealing when the weather is nice, existing research support that weather is one of the most significant factors that impact the demand for cycling in various countries including Australia, Austria, USA, Canada, Netherlands and Singapore (Brandenburg et al., 2007; Thomas et al., 2013; Miranda-Moreno and Nosal, 2011; Nosal and Miranda-Moreno, 2012; Nankervis, 1999; Mathisen et al., 2015). Similar results have been found for bus ridership (Wei et al., 2018; Syeed et al., 2013). In fact, after 4 h of rain, bike sharing demand decreases by 28.0%, subway and bus demand decreases by 4.6%, while taxi increases by 13.9% (Lepage and Morency, 2020). Even incorrect weather forecasts can impact bike demand. For instance, forecasted rain can decrease bike traffic by 3.6% in periods that end up being rain-free (Wessel, 2020).

Given the above, we hypothesize that people are more likely to support the installation of solar panels and environmentally friendly forms of transport (e.g., walking, bicycle, public transport) if they are solicited on a sunny day compared to a rainy one. Based on the Ajzen's theory of planned behavior (Ajzen, 1991), which postulates that behavior is not only guided by intentions but also by beliefs. More precisely, behavioral intentions are directly related to individuals' perceptions of the norms regarding the behavior and the perceived behavioral control, i.e. whether one beliefs that its behavior successfully promotes the desired goal. Thus, intentions to adopt pro-environmental behaviors are directly related to beliefs about normative behaviors (Oreg and Katz-Gerro, 2006). Consequently, if people associate nice weather with a higher propensity to buy solar panels and to adopt ecological transport modes, they can perceive, as a result, that these environmentally friendly alternatives will deliver higher levels of environmental benefits.

From a rational perspective, the weather at the time of the survey administration should not have any impact on beliefs and behavioral

[1] The hedonic adaptation describes the human tendency after a positive or negative event (e.g., lottery winners versus accident victims) and subsequent increase in positive or negative feelings to quickly adapt to affective experiences and return to their baseline level of happiness.

intentions for decisions that have long term consequences. Based on the previous discussion, we formulate the two following hypotheses:

H1. People will express more favorable beliefs on the ecological efficiency of adopting environmentally friendly alternatives when the weather at the survey administration day is congruent with the suggested environmentally friendly propositions.

H2. People will express higher behavioral intention of adopting environmentally friendly alternatives when the weather at the survey administration day is congruent with the suggested environmentally friendly propositions.

3. Materials and methods

In order to test these hypotheses, we designed a between-subjects experimental survey (Weber, 1992; Croson et al., 2007) that was identical but administrated either during sunny days (T1) or during rainy days (T2) as indicated in the local weather bulletin.[2] Surveys were administered by research assistants under similar conditions (i.e. day, time-schedule and place) to avoid the introduction of potentially confounding factors. The questionnaire was pretested on a small convenience sample (N = 10), not included in the end sample, in order to improve its reader friendliness.

3.1. Questionnaire

The survey instrument (see Appendix 1) focusses on two domains where environmental improvements can be made, precisely solar energy as an alternative to fossil energy and eco-friendly transport such as walking, biking or public transport. These two domains have been selected first, for their high level of realism (see e.g., Zander, 2020). For instance, French authorities encourage individuals to install solar panels thanks to financial incentives (Ministère de l'Economie des Finances, 2020). Similarly, in France, private and public employers encourage their employees to cycle by paying them a kilometric allowance, with tax advantages (Club des Villes et Territoires Cyclables, 2020). Financial incentives also exist to push people to use public transport to commute. A second reason for selecting these two domains is related to the different types of effort necessary to induce a behavioral change. Purchasing solar panels implies an important up-front cost, whereas adopting eco-friendly transport modes requires more convenience sacrifices such as time and physical efforts. Attari et al. (2016) stress that pro-environmental goals can be distinguished according to their perceived effectiveness and the perceived difficulty of the changes. They found that endorsement of conservation goals decreases steeply as a function of perceived difficulty. In the case of solar panels, there are high upfront costs, but once the installation is made, the change is likely to be perceived as effective and easy. Conversely, in the case of transportation mode change, the immediate monetary cost can seem close to zero (e.g., walking), but a permanent change can be perceived as difficult, except if the surveyed individual has already adopted the considered change. Indeed, ecological transport habits can easily get lost after external shocks, such as cold weather, lack of time, deflated bike, or the need to shop after work (Verplanken et al., 2008). Overall, the two considered domains are intimately connected to the weather. Solar panel are expected to be more efficient on sunny days and eco-friendly transport would be more enjoyable under good weather conditions.

All participants faced the two domains in a fixed order, precisely, solar panels first and eco-friendly transport afterwards.[3] After a brief introduction on the environmental and private benefits associated to solar panel and eco-friendly transport (see the survey instrument in Appendix 1),[4] we asked individuals whether they believe that investing in solar panels and using eco-friendly transport are beneficial to protect the environment.[5] We also solicited them to indicate their willingness to adopt behavioral changes, i.e., purchase of solar panels and adoption of eco-friendly transport to go to their workplace. Participants indicated their answers to the main questions on a 4-point Likert scale ranging from 1 (e.g., very unlikely) to 4 (e.g., very likely). Our choice of a 4-levels scale was motivated by the willingness to avoid the neutrality heuristics, by selecting the neutral option by selecting 3 on a 5-point scale. A forced-choice scale reduces response biases, as respondents might select a midpoint even if their true opinion is not neutral. Research has shown that for coarse scales with few alternatives, it is better to omit the midpoint (Matell and Jacoby, 1972; Raaijmakers et al., 2000).

3.2. Study area and sampling strategy

The pen and pencil questionnaires were administered in February 2019 to a sample of bystanders solicited on a voluntary and random basis in the metropolitan area of Montpellier, an often sunny city in the South of France, where solar panel and eco-friendly transport are well publicized. People were approached and invited to participate to an anonymous survey without mentioning its theme. This sample can be considered as a convenience sample, and as such could raise some concerns (e.g., generalizability) among scholars. Nevertheless, these concerns are not necessarily justified, especially when the researcher is interested in qualitative information (see Mullinix et al., 2015), on whether a day's weather will influence pro-environmental preferences and self-stated intentions. Precautions were taken to prevent participants from discovering the manipulated variable and noteworthy, no participant detected the real purpose of the study. We made sure that sample sizes for both treatments T1 (sunny day) and T2 (rainy day) were above 100 observations for each treatment to ensure sufficient predictive power.[6]

[2] The binary distinction used (sunny versus rainy days) is simplistic. We recommend to use more nuanced distinctions regarding the characterization of weather (e.g., temperature, luminosity, clouds). Moreover, all sunny days or rainy days are not created equal. For instance, a sunny day out of season compared to a similar sunny day in the season can impact differently the results. Nevertheless, these issues are beyond the scope of our paper and constitute interesting extensions.

[3] Even if we agree that we cannot completely rule out the risk of carryover or contamination due to the question order, we would like to argue that it is not a crucial issue in our paper, given our research question and survey design. First, the two domains are very different and likely to mobilize distinct behavioral levers. In addition, the order in our case is unlikely to impact our treatment outcome, as we do not seek to evaluate the interest for the environmentally friendly initiatives *per se* or make within subject comparison. It is well admitted that order bias induced by sequential treatments needs more to be controlled for within subject design (Charness et al., 2012). Indeed, we are not really interested in the absolute levels of response *per se* but we focus on between subject comparisons instead. Consequently, if there is a contamination due to question order, the effect will be similar in the two considered treatments and less likely to affect our research question.

[4] There can be a 'desirability' bias as respondents are motivated to answer the survey questions in a way that reinforces behaviors that are socially desirable (or those projected by the researcher) and avoid those that are not. Given that the same description was given in both treatments, differences if any, cannot be attributed to this desirability bias.

[5] We run a power analysis using the G*power software to determine the minimum sample size required based on data collected during a pilot phase. The analysis revealed that we needed a minimum sample size of 130 observations to detect an effect size of 0.2 (alpha = 0.05; beta = 0.90).

[6] Data was collected using a 4-point Lickert scale. The possible answers concerning beliefs were 1-don't agree at all, 2-don't agree, 3-agree, 4-totally agree. For the behavioral intention to purchase solar panels, participants could choose between 1-very unlikely, 2-unlikely, 3-likely, 4-very likely, and for the intention to adopt eco-friendly transport, 1-never, 2-sometimes, 3-often, 4-every day. More detailed results are available upon request.

4. Data analysis

We gathered 218 observations with complete information. To analyze our data, we use STATA software-V14. We collected data on age, gender, financial situation, level of education as well as about their transportation habits and frequency of using car, bike, public transport or walking (see Table 1a.). 69% of respondents are females. 39% of the sample use frequently their car, 51% never bike, 13.8% (respectively 26%) walk (use public transport) infrequently (i.e. either never or only sometimes). These control variables allow us to distinguish the population who could be more motivated to adopt eco-friendly transport in the future.

Some descriptive statistics regarding the distribution between the two treatments are provided in Table 1b. Both samples are rather well balanced, except regarding the female proportion and proportion of individuals using public transports very little or never that are higher in T1.

Table 2 report the average ratings[7] of beliefs and behavioral intentions regarding solar panels and eco-friendly transport. By comparing average ratings, using the Wilcoxon-Mann-Whitney two-sample rank-sum test, we find that 1) surveyed individuals believe that solar panels are more beneficial for the environment on a sunny day than on a rainy day, and 2) they are more willing to adopt an eco-friendly transport mode when they fill in the questionnaires under sunshine than when it rains.

Moreover, the Spearman test shows that the trend of the means for the ordered dependent variables across treatments are not equal for beliefs on the benefits of solar panels ($\rho = 0.075$) and for the intention to adopt eco-friendly transport ($\rho = 0.022$). Also, results[8] do not vary according socio-economic variables (gender, age, financial situation or educational level). Both men and women are sensitive to weather conditions and have higher beliefs that solar panels are beneficial for the environment, and are more prone to adopt eco-friendly transport on sunny days.

We run an ordered probit regression (Table 3) to explain participants' beliefs about the environmental benefits of solar panels and their intention of purchase by controlling for some socio-demographic variables. The ordered probit model, where parameters are estimated using Maximum Likelihood Estimation, explains the variation in ordered categorial dependent variables. Data supports that the day's weather at the administration time impacts beliefs about the environmental benefits of solar panels, but not the purchase intention of participants.

Table 1a
Descriptive statistics (N = 218).

Variable	Mean	S.D.	Min	Max
Age	28.12	14.562	16	93
Gender (Men = 1)	0.307	0.462	0	1
Financial situation (average)	2.225	0.737	1	4
1=Very tight	0.165	0.372	0	1
2=Tight	0.463	0.5	0	1
3=Comfortable	0.353	0.479	0	1
4=Very comfortable	0.018	0.135	0	1
Education level (average)	2.381	0.589	1	3
1=Undergraduate	0.055	0.229	0	1
2=Licence	0.509	0.501	0	1
3=Master degree or more	0.436	0.497	0	1
Frequency of transport			0	1
Car - *frequently*	0.39	0.489	0	1
Bike - *never*	0.509	0.501	0	1
Feet - *infrequently*	0.138	0.345	0	1
Public transport - *infrequently*	0.261	0.44	0	1

[7] More detailed results related to socio-demographic variables are available upon request.

Table 1b
Descriptive statistics regarding the two treatments T1 and T2.

Variable	*T1 (Sunny)* N = 105	*T2 (Rainy)* N = 113	Wilcoxon rank sum test
Age	27.93 (15.32)	28.29 (13.88)	0.62
Gender *(Men=1)*	0.248 (0.434)	0.363 (0.483)	0.07*
Financial situation (average)	2.267 (0.677)	2.186 (0.774)	0.392
1=Very tight	0.133 (0.342)	0.195 (0.398)	0.224
2=Tight	0.476 (0.502)	0.451 (0.5)	0.714
3=Comfortable	0.381 (0.488)	0.327 (0.471)	0.41
4=Very comfortable	0.01 (0.098)	0.027 (0.161)	0.351
Education level *(average)*	2.381 (0.595)	2.381 (0.587)	0.98
1=Undergraduate	0.057 (0.233)	0.053 (0.225)	0.9
2=Licence	0.505 (0.502)	0.513 (0.502)	0.9
3=Master degree or more	0.438 (0.499)	0.434 (0.498)	0.947
Frequency of transport			
Car - *frequently*	0.352 (0.48)	0.425 (0.497)	0.275
Bike - *never*	0.514 (0.502)	0.504 (0.502)	0.885
Feet - *infrequently*	0.105 (0.308)	0.168 (0.376)	0.176
Public transport – *infrequently*	0.21 (0.45)	0.31 (0.464)	0.093*

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

Table 2
Average ratings of beliefs and behavioral intentions regarding solar panels and eco-friendly transport (S.D. indicated in brackets).

Variable	*T1 (Sunny)* N = 105	*T2 (Rainy)* N = 113	Wilcoxon rank sum test
Solar panels			
Beneficial for the environment (=Belief)	3.28 (0.563)	3.08 (0.746)	**0.075***
Purchase (=Behavioral intention)	2.68 (0.803)	2.69 (0.846)	0.8
Eco-friendly transport			
Beneficial for the environment (=Belief)	3.76 (0.45)	3.646 (0.55)	0.119
Adopt (=Behavioral intention)	3.55 (0.734)	3.32 (0.837)	**0.022****

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

Purchase intention is only explained by socio-demographic variables. Indeed, the more participants feel comfortable financially, the more they express willingness to purchase solar panels whereas their education level and age reduce this probability. Noteworthy, the relatively low age average of our sample may also explain the lower variability among purchase intention of solar panel, a long term investment, as younger individuals may have less stable financial and housing situations than older individuals.

On sunny days, a greater proportion of people judge solar panels to be beneficial for environmental protection. Table 4 shows the marginal effects with which the weather conditions at the survey administration impact beliefs. We observe an increase of 0.111 of the proportion of people declaring solar panels to be very beneficial. Said differently, the probability to believe solar panels are very beneficial for environmental protection increases with 0.111 points on sunny compared to rainy days.

Table 3
Ordered probit regression for environmental benefits beliefs and purchase intention regarding solar panels.

Variable	Beneficial investment (belief)		Purchase (behavioral intention)	
	Model 1	Model 2	Model 1	Model 2
Treatment				
T1 : Sunny day	**0.317**** (0.155)	**0.28*** (0.157)	−0.03 (0.149)	−0.06 (0.151)
Gender		**−0.435***** (0.173)		−0.067 (0.166)
Age		−0.008 ((0.005)		**−0.013***** (0.005)
Financial situation		0.089 (0.16)		**0.23**** (0.103)
Education level		−0.215 (0.133)		**−0.265**** (0.129)
Log Likelihood	−211.15	−204.31	−248.64	−240.73
LR Chi2	4.2**	17.89***	0.04	15.85***
Pseudo R2	0.01	0.042	0.0001	0.032
Nb of obs.	218	218	218	218

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

Table 4
Marginal effects of sunny weather on the belief that solar panels are beneficial for the environment.

Belief that solar panels are beneficial for the environment	Marginal effect	
	Model 1	Model 2
Don't agree at all	−0.013 (0.008)	−0.011 (0.007)
Don't agree	**−0.047**** (0.024)	**−0.04*** (0.023)
Agree	**−0.051*** (0.027)	**−0.044*** (0.027)
Totally agree	**0.111**** (0.054)	**0.094*** (0.053)

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

By opposition, the probability to judge solar panels to not be very beneficial for environmental protection (resp. only beneficial) decreases with 0.047 points (resp. 0.051 points) on a sunny day. As the two samples are unbalanced related to gender, we see that the actual increase is somewhat reduced by considering socio-demographic variables into the model (i.e., increase of 0.094 points in Model 2). Indeed, men have lower beliefs on the environmental benefit of solar panels. As a possible explanation, McLeish and Oxoby (2009) identify pervasive gender stereotypes pertaining to intertemporal choices: women are more patient than men.

Concerning eco-friendly transports, the results are more pronounced as the weather conditions at the time of the survey impact both beliefs and behavioral intentions. Indeed, Table 5 indicates that sunny weather at the time of survey administration impacts positively the participants' beliefs that environmentally friendly transports contribute to the protection of the environment. This result is robust when considering socio-demographic variables, and shows that weather conditions seem to be the main explanatory factor. Interestingly, the probability to adopt an eco-friendly transport mode decreases when respondents use frequently their car, don't bike, walk little and don't use public transport frequently. This result is consistent with the status quo bias (Samuelson and Zeckhauser, 1988). Of course, a behavioral change is far more complicated (respectively, easier) for people who use their car (respectively public transport) frequently and those who are not accustomed to eco-friendly transports. Interestingly, increases in beliefs and behavioral intentions are associated with a carryover effect from ambivalent classes

Table 5
Ordered probit regression for eco-friendly transport/beliefs and behavioral changes.

Variable	Positive ecological impact (belief)		Adoption (behavioral intention)	
	Model 1	Model 2	Model 1	Model 2
Treatment				
T1 : Sunny day	**0.298*** (0.178)	**0.31*** (0.182)	**0.368**** (0.162)	**0.306*** (0.169)
Gender		0.186 (0.212)		0.1 (0.194)
Age		0.002 (0.007)		−0.009 (0.006)
Financial situation		−0.067 (0.122)		0.022 (0.114)
Education level		0.018 (0.154)		0.034 (0.139)
Frequency transport				
Car - *frequently*		0.178 (0.206)		**−0.363**** (0.184)
Bike - *never*		−0.1 (0.187)		**−0.467***** (0.177)
Feet - *infrequently*		−0.047 (0.27)		**−0.593**** (0.238)
Public transport - *infrequently*		−0.349 (0.237)		**−0.571***** (0.222)
Log Likelihood	−144.08	−142.46	−213.64	−194.76
LR Chi2	2.81*	6.05	5.2**	42.97***
Pseudo R2	0.01	0.021	0.012	0.1
Nb of obs.	218	218	218	218

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

(selecting 2 or 3 on the Likert scale) as illustrated by Table 6a and Table 6b, suggesting that the projection bias affects mainly people at the frontier of behavioral change.

Table 6a shows the marginal effects with which the weather conditions at the survey administration impact beliefs. Precisely, we observe an increase of 0.1 points for people totally agreeing with the statement that eco-friendly transports are beneficial for the environment. This increase is very similar to results related to beliefs of environmental efficiency for solar panels. One of the explanations might be that nice (resp. bad) weather affects moods positively (resp. negatively) (Lucas and Lawless, 2013), and impact rational reasoning (Jung et al., 2014).

Regarding the intention to adopt eco-friendly transport (Table 6b), weather conditions are also determinant. The probability to be willing to use an environmentally friendly transport mode "every day" is increased by 0.141 points on sunny compared to rainy days. By opposition, the probability to use an environmentally friendly transport mode "often" (resp. only "sometimes") is reduced by 0.07 points (resp. 0.055 points). As the sample is unbalanced regarding the use of public transport, the impact of weather conditions is somewhat reduced when considering

Table 6a
Marginal effects of sunny weather at the administration time on beliefs of environment benefit of ecological transport.

Belief that eco-friendly transport is beneficial for the environment	Marginal effect	
	Model 1	Model 2
Don't agree at all	–	–
Don't agree	−0.015 (0.032)	−0.016* (0.011)
Agree	**−0.083*** (0.05)	**−0.085*** (0.05)
Totally agree	**0.1*** (0.058)	**0.101*** (0.059)

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

Table 6b
Marginal effects of sunny weather at the administration time on willingness to adopt eco-friendly transport.

Behavioral intention to adopt eco-friendly transport	Marginal effect	
	Model 1	Model 2
Never	−0.016 (0.009)	−0.01 (0.007)
Sometimes	**−0.07**** (0.032)	**−0.053*** (0.03)
Often	**−0.055**** (0.025)	**−0.04*** (0.023)
Every day	**0.141**** (0.061)	**0.104*** (0.057)

***, **, and * refer to parameter significance at the 1%, 5% and 10% levels, respectively.

socio-demographic variables.

Interestingly, increases in beliefs and behavioral intentions are associated with a carryover effect from ambivalent classes (selecting 2 or 3 on the Likert scale) as illustrated by Table 6a and Table 6b, suggesting that the projection bias affects mainly people at the frontier of behavioral change.

5. Discussion and policy implications

A natural implication of our results is to subtly use the weather variations to schedule some activities such as prospecting new clients for solar panels on sunny days rather than rainy ones. Similarly, our findings encourage the use of commitment devices when the weather is good to make behavioral intentions, such as the use of eco-friendly transport, more lasting. Similarly, interested influencers can get polls more aligned with their interests by cleverly selecting the day on which respondents will be solicited. People may be more likely to support initiatives to fight climate change if they are solicited a congruent day. We also encourage decision makers to not take all survey results at face value and replace them in their context (Van den Broek et al., 2019). Weather-based nudges or other tactics exploiting the projection bias of individuals can provide a refreshing way to better understand attitudes and behaviors. They enrich the policy toolbox to advance the environmental agenda, but should not divert the attention from more effective instruments that frequently require higher levels of political courage (Schubert, 2017).

An additional insight involves the examination of de-biasing approaches (Lilienfeld et al., 2009) such as informing (and training) people at the right time about the bias presence and effects or using the testimony of relevant people who have successfully crossed the line. Another strategy to counterbalance an undesirable projection bias effect can be to design and implement cooling-off periods during which people can reverse their decisions.

Our findings do not inform policymakers on the magnitude of the projection bias. Given that the projection bias does not occur in a vacuum, it is likely to interact with other biases such as loss/gain framing, making the combined effect more complex. In addition, the robustness of our findings can be tested on other items such as the purchase of flood protection devices on rainy days or the proposal of introducing windbreak measures on windy days. Rather than providing a clear cut and definitive conclusion, our results constitute a vibrant call to stimulate further research on the projection bias in the environmental realm.

6. Study limitations

Our experimental survey has several limitations, such as a sample bias due to the self-selection of respondents, the high proportion of young respondents in the sample, the lack of some control variables, such as their environmental attitudes. Moreover, we do not measure a real behavioral change, nor employ an incentive-compatible design, which could constitute the next steps for future research. The binary distinction used (sunny versus rainy days) is simplistic. We recommend to use more nuanced distinctions regarding the characterization of weather (e.g., temperature, luminosity, clouds). Moreover, all sunny days or rainy days are not created equal. For instance, a sunny day out of season compared to a similar sunny day in the season can impact differently the results. Also, we did not control for attitude towards the weather, which may also impact individual's mood. Future research may include additional questions on how people feel on that particular day to test for the impact of weather induced emotions on individual decisions. Considering other nudges based on the projection bias also deserves more attention.

Our findings are consistent with the projection bias, even if it is difficult to completely rule out alternative explanations, such as salience or myopic preferences. Even if we caution the reader to not over-interpret or over-generalize from our results, we argue that projection bias deserves more attention from scholars and practitioners. We discussed some ways to de-bias individuals, but these strategies remain to be tested to assess their effectiveness in relationship with the projection bias.

7. Conclusion

Our work offers refreshing insights that can help to understand how *a priori* irrelevant contextual elements such as the day weather can influence and bias beliefs, attitudes and behavioral intentions regarding the adoption of energy-efficient solutions. Our findings are consistent with the recommendation of devoting more attention to the System 1 intuitive thinking and to design adapted policies. Rather than just encouraging a logical and rational choice, policymakers can tap in the System 1 thinking by also making the recommended choice an intuitive one. For instance, we offered preliminary evidence that simple and inexpensive contextual elements, such as the day's weather, could have a significant impact on the adoption of energy-efficient solutions. We also suggested some implications that can help influencers to get more support aligned with their vested interests.

The human tendency to over-rely on current situations to predict future states can be detrimental or conducive to the adoption of environmentally friendly initiatives. We showed that the day's weather at the time of survey administration is likely to impact beliefs and behavioral intentions in the environmental realm. More precisely, sunny days have a positive impact on beliefs regarding the ecological relevance of certain pro-environmental behaviors and can even encourage behavioral changes.

CRediT authorship contribution statement

Sophie Clot: Conceptualization, of the experimental protocol, Formal analysis, Writing – original draft, Writing – review & editing. **Gilles Grolleau:** Conceptualization, of the experimental protocol, Formal analysis, Writing – original draft, Writing – review & editing. **Lisette Ibanez:** Conceptualization, of the experimental protocol, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2021.112645.

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