



The role of implicit theories about climate change malleability in the prediction of pro-environmental behavioral intentions

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Received: 20 August 2021 / Accepted: 9 June 2022
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Abstract

Understanding the variables that influence pro-environmental intentions is key to promoting pro-environmental actions. In this research, we analyze how the sense of responsibility toward climate change and implicit theories about climate change (ITCC) interact to condition individual pro-environmental intention. A total of 48 psychology students with a mean age of 19 years were randomly divided into two experimental groups and participated in a pretest–posttest experiment. The experimental manipulation consisted of reading a news extract regarding scientific research: one group was given information stating that climate change is still reversible, instilling incremental ITCC; the other group was given the opposite information, instilling static ITCC. The results of the one-way ANOVA ($F=4.206$, $p < .05$) showed that people with incremental ITCC presented a greater intention to behave in a pro-environmental way than did individuals with static ITCC. Moreover, the moderating analysis showed that ITCC act as a moderating variable in the relationship between the sense of responsibility and pro-environmental behavioral intentions. The sense of responsibility predicted pro-environmental behavioral intentions when individuals held incremental ITCC ($p < .01$) but not when they held static ITCC ($p = .901$). This research emphasized the relevance of promoting incremental ITCC interventions in the environmental education field, as the sense of responsibility toward climate change is deterministic but not in itself enough to acquire the intention to behave in a pro-environmental way.

Keywords Implicit theories about climate change · Environmental responsibility · Pro-environmental behavioral intention · Experiment · Pretest–posttest

1 Introduction

From a scientific point of view, climate change is one of the most concerning environmental issues, because of the aggravation and speed of the potentially negative consequences for the planet (Bouman et al., 2020; Brulle et al., 2012; O’Neill et al., 2017). The Synthesis

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Report (SYR) of the International Panel of Climate Change (IPCC) Fifth Assessment Report (IPCC, 2014, p. 40) left no room for doubt: “Human influence on the climate system is clear” and “Recent climate changes have had widespread impacts on human and natural systems.” Moreover, the SYR provides evidence for the need to effectively implement adaptation and mitigation strategies to address climate change, effectuated through integrated responses at all scales, linked with other societal objectives. More recently, the findings of the Working Group I contribution to the IPCC’s Sixth Assessment Report (IPCC, 2021, p. 5) reaffirm that “It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes [...] have occurred.” At least in the last 2000 years, our climate system has been changing rapidly and at unprecedented rates, unquestionably due to human activity, the principal driver of climate change (IPCC, 2021). Slowing climate change implies that society is fully aware of this problem; then, interventions that promote a change in behavior toward a more pro-environmental approach are required to reduce environmental pollution. For this reason, scientific research should focus on analyzing the possible individual and collective variables that support pro-environmental behavior and the socioeducational interventions capable of activating this kind of behavior.

Many researchers have sought to explain why individuals do or do not behave in a pro-environmental way, focusing on knowledge–action systems that attempt to explain the dynamic relationship between knowledge, attitudes and behavior (Bell et al., 2013; Gifford, 2014). However, linear models (which claim that greater environmental knowledge and concern for the environment predict high levels of pro-environmental attitudes in individuals, leading them to behave in a more pro-environmental way) have been harshly criticized and even called deficit models (Burgess et al., 1998) because the individual knowledge and concern for the environment is not often accompanied by the expected pro-environmental behavior.

Indeed, human beings are complex and, as indicated by the cognitive-affective-personality system (Mendoza-Denton et al., 2001; Mischel & Shoda, 1995; Mischel et al., 2002; Shoda & Mischel, 2006), there are many elements that can intervene in their behavior: dispositional personal factors (knowledge about the environment, social status, perceptions, depictions and conceptions of the world, etc.), motivational factors (motivation, emotions, self-efficacy, sense of responsibility, etc.) and external factors (from the physical and social environment itself: social pressure, social group, culture, access to recycling bins, etc.). Moreover, all these elements interact with each other to explain the individuals’ behaviors (Mendoza-Denton et al., 2001; Mischel & Shoda, 1995; Mischel et al., 2002; Shoda & Mischel, 2006). Consequently, analysis of the different psychosocial variables that influence pro-environmental behavior, as well as their interactions, is essential. For this reason, in this research we intend to analyze how certain psychosocial variables interact to explain pro-environmental behavior.

1.1 Implicit theories of climate change and pro-environmental actions

Several studies have supported the idea of the inclusion of social representations as good practice in environmental education (Castro, 2006). In particular, social representations about the world, such as implicit theories (IT) about reality, could be especially relevant. The concept of IT is derived from Dweck and Leggett’s social-cognitive theory of motivation (SCTM; Dweck & Leggett, 1988; Dweck & Yeager, 2021). These IT are relatively stable explanations or beliefs that individuals possess about the malleability of personal

attributes, such as intelligence (Blackwell et al., 2015) or leadership capacity (Lord et al., 2020), or even attributes of the world (e.g., climate change). People can have static IT (believing that personal or world attributes cannot change) or incremental IT (believing that these attributes are modifiable). They are called “theories” because they offer an organized scheme of knowledge about the functioning of the physical or social world; and they are “implicit” because they tend to operate unconsciously: although people present them and apply them, they usually are not able to verbalize them in elaborate and coherent speech (Dweck & Leggett, 1988; Dweck & Yeager, 2021).

Therefore, the SCTM (Dweck & Leggett, 1988; Dweck & Yeager, 2021) provides a strong theoretical framework according to which the assumptions that individuals have about the world guide their decisions and ultimately influence their behaviors. Incremental and static IT lead individuals to different motivational processes and goals, which can lead them to adopt different behavioral patterns in the face of challenging situations. These two different ways of perceiving the world—static or incremental—are related to behaviors oriented toward mastery and success (incremental perception) or, on the contrary, to behaviors oriented toward avoidance and failure (static perception). These socially internalized IT constitute a precedent for emotional, self-regulatory and behavioral patterns and should be one of the bases for achieving changes in human behaviors that could intervene in climate change.

But how does this theory about IT and climate change and pro-environmental behaviors relate? Although there is practically no controversy over the existence of global warming and the consequent climate change, there is still heated debate about whether warming can be stopped through specific actions of individuals and society in general or if warming is already irreversible (Markandya, 2009). Some individuals understand that climate change is already irreversible, whereas others firmly believe that it can still be slowed and reversed. This different perception about the possibility (or not) of change or the reversibility of global warming is related to IT about the world (Chiu et al., 1997; Dweck et al., 1995; Yung-Jui & Ying-Yi, 2010), which refer to individuals’ beliefs about whether the social world and its institutions can be modified (incremental IT) or whether they cannot change (static IT). As explained by Yung-Jui and Ying-Yi (2010), people with static beliefs about the world perceive that the social and institutional world consists of fixed characteristics that cannot be changed. On the other hand, people with incremental theories about the world think that the social world and its institutions consist of characteristics that can change and improve. Individuals can have IT about different elements (from about one’s own intelligence to about the world in general), and one of these elements is climate change. Therefore, we will name the beliefs about whether climate change is reversible or not “implicit theories of climate change” (ITCC), which can be incremental when individuals believe that climate change is modifiable and reversible, or static when individuals believe that climate change is no longer modifiable (i.e., irreversible).

Beliefs about the environment are defined as part of the psychological component that explains the pro-environmental behavior of human beings (Correa & Rodrigo, 2001) and numerous research studies have concluded that beliefs can be direct precursors of ecological behavior. Based on the theory of Dweck and his followers (Chiu et al., 1997; Dweck et al., 1995; Dweck & Grant, 2008; Dweck & Leggett, 1988; Dweck & Yeager, 2021; Yung-Jui & Ying-Yi, 2010), it could be deduced that individuals with incremental ITCC will adopt a behavior that is more oriented to dominance and achievement in their relationship with the environment, trying to change and improve the situation. Consequently, in situations where individuals must choose whether to adopt an ecological behavior, people with incremental IT will more easily choose pro-environmental behavior. In contrast,

people who assume that climate change is an immutable fact will adopt helpless behavior patterns, thus avoiding pro-environmental behavior, which will be viewed as doomed to failure (see Fig. 1). In this sense, previous nonexperimental studies have found a relationship between the IT of people and their environmental behaviors (Duchi et al., 2020; Solomon & Wilson, 2017).

Although the fact that believing in the reversibility of climate change may lead us to more pro-environmental behaviors may seem like common sense, it should be noted that, if demonstrated, it would have relevant practical repercussions. This would indicate that changing this assumption could influence individuals to behave in a more pro-environmental way. And although these IT are relatively stable, it has been shown that they are subject to influences and can change. People can be persuaded to momentarily display an adherence to either a static or incremental theory by reading scientific articles that defend one stance or another (Dweck & Grant, 2008). Furthermore, in the environmental sense, there is evidence that manipulation of the individual context infers IT in either direction (Correa & Rodrigo, 2001).

According to the literature summarized above, we hypothesized that people with incremental ITCC are more prone to carry out pro-environmental actions than individuals with static ITCC.

1.2 Relationship between responsibility, implicit theories about climate change and pro-environmental behavior

An individual's sense of responsibility toward the environment can be crucial in turning personal attitudes and values into action. Responsibility promotes the feeling that behaviors can have a real impact on the environment (Punzo et al., 2019). The sense of responsibility can lead people to believe that it is up to them to make the effort to improve valued

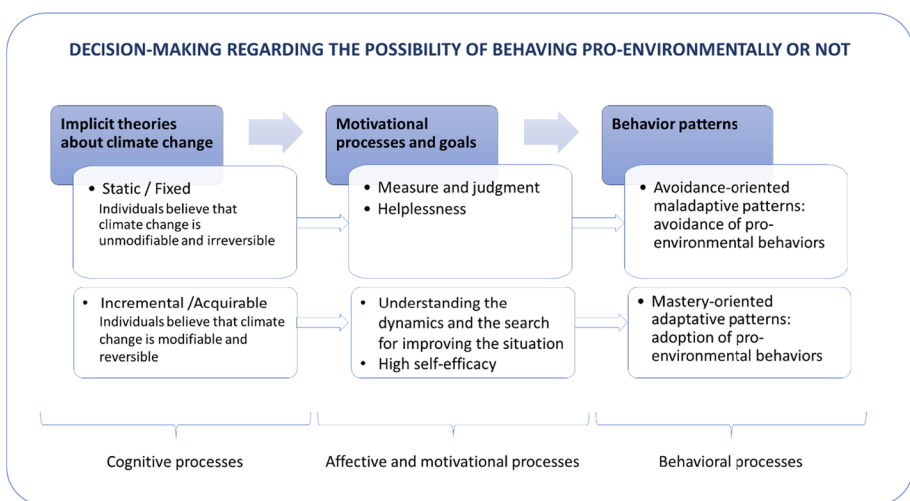


Fig. 1 Adaptation of the Social-Cognitive Theory of Motivation of Dweck (Dweck & Leggett, 1988; Dweck & Yeager, 2021) to the Implicit Theories of Climate Change

situations, instead of transferring this responsibility to others (Bateman & O'Connor, 2016; Gifford et al., 2011).

This psychological factor is one of the keys to explaining the multiple anthropogenic causes of climate change. The sense of responsibility is a psychological construct that allows people to carry out certain action when they perceive that someone or something (in this case, the planet) needs our help. Thus, on many occasions, pro-environmental inaction could be due to the absence of this construct, which gives us an idea of its potential impact (Bateman & O'Connor, 2016). The theory of perceived responsibility and social motivation (Weiner, 2006) suggests that the causal attribution of social problems, such as climate change, influences the perception that individuals have about their responsibility regarding those social problems, which affects their emotional and behavioral responses.

In this sense, numerous studies have confirmed the relationship between the sense of responsibility and pro-environmental behavior (Bouman et al., 2020; Punzo et al., 2019). Data from the Eurobarometer (Directorate-General for Climate Action, 2017) suggest that the sense of responsibility is the variable that most directly and significantly affects individual pro-environmental action, among other variables such as social values, moral values or the moral coefficient. Moreover, the degree to which factors such as global citizenship, the moral coefficient and the mentality of society affect the sense of individual responsibility and, indirectly, positive environmental behaviors, has been studied (Janmaimool & Khajohnmanee, 2020). Likewise, the sense of responsibility strongly predicts the intention to act pro-environmentally and various kinds of environmental behaviors, with different studies having shown that higher levels of corporate social responsibility directly influence the pro-environmental behavior of individuals in their jobs (Attaran & Celik, 2015; Fielding & Head, 2012; Reese & Jacob, 2015; Wenshun et al., 2011).

However, considering the SCTM (Dweck & Leggett, 1988; Dweck & Yeager, 2021), we could ask ourselves whether the individuals who feel responsible for climate change will always have the intention to carry out pro-environmental behaviors. As explained earlier, the SCTM (Dweck & Leggett, 1988; Dweck & Yeager, 2021) would indicate that IT guide decisions and influence individuals' behaviors, leading static and incremental IT to different motivational processes and goals when facing challenging situations. In this sense, a question that could be posed is whether individuals who possess high responsibility regarding climate change will have the intention to behave in this way if they also possess static ITCC. This behavior does not seem to be adaptable. If static ITCC lead individuals to helpless behavioral patterns, does their high responsibility influence their pro-environmental behavior?

On the other hand, different studies have found that IT can play a moderating role between different variables in fields other than pro-environmental behavior (Butler, 2000; Knee et al., 2004; Yung-Jui & Ying-Yi, 2010). In this sense, the social-cognitive approach and the theoretical framework of IT help us to understand the mechanisms through which an individual persists in complex situations and makes decisions (Tabernero & Wood, 2009). Therefore, the relevance of studying the possible interaction between feeling responsible for climate change and perceiving that climate change can (or cannot) be reversed is worth noting (i.e., the interaction relationship between the sense of responsibility for climate change and ITCC). In this sense, it is easy to think that how much an individual feels responsible for climate change does not matter if he or she presents static ITCC, that is, if such an individual perceives that there is nothing that can be done to reverse climate change or that we have already reached a point of no return. This individual will perceive that there is no point in acting in a pro-environmental way and therefore will not engage in pro-environmental behaviors. In contrast, when individuals feel responsible

and perceive that climate change is reversible, this will lead them to implement pro-environmental behaviors. In other words, the perception of greater responsibility for climate change coupled with incremental ITCC will induce greater pro-environmental behavior, whereas when it is coupled with static ITCC the likelihood of adopting pro-environmental behavior will be reduced.

Congruent with the discussion above, we expect to find that ITCC act as a moderator in the relationship between responsibility for climate change and intentions to behave in a pro-environmental way. A greater sense of responsibility for climate change leads individuals to higher intentions to behave pro-environmentally only when they hold incremental ITCC, but not when they hold static ITCC.

1.3 Objectives and Hypotheses

In this research, the main objective was to analyze how ITCC and the sense of responsibility toward climate change interact to explain the pro-environmental behavioral intentions of individuals. In the frame of this objective and the previous literature, the following study hypotheses were proposed:

H1: Individuals with incremental ITCC display greater pro-environmental behavioral intentions than do individuals with static ITCC.

H2: ITCC act as a moderating variable in the relationship between responsibility toward climate change and pro-environmental behavioral intention: when individuals have incremental ITCC, perceiving greater responsibility for climate change leads them to have the intention to behave in a pro-environmental way; however, when individuals have static ITCC, the degree of responsibility they feel toward climate change does not influence their pro-environmental behavioral intentions.

2 Method

2.1 Procedure

After approval of the Research Ethics Committee of Córdoba (Spain), with reference number 4429, students were enrolled during a psychology class by one of the researchers. Participation was voluntary and no incentives were given. Before taking part in the study, the participants gave their informed consent. They were informed that the objective of the study was to analyze their perception about the natural environment.

Once students gave their informed consent to participate, they were randomly assigned to one of two conditions (a malleable and a fixed condition) to perform the pretest–posttest experimental study (see Fig. 2 for a schematic representation of the procedure used). The manipulation consisted of each experimental group being assigned to read a different alleged scientific article (see Appendices 1a and 1b) to inoculate the participants with incremental (experimental group G1) or static (experimental group G2) ITCC. This manipulation structure has been used previously in studies on IT (Bauer & Hannover, 2020; Walton & Cohen, 2007). The text read by both experimental groups was presented as a short newspaper article on recent research

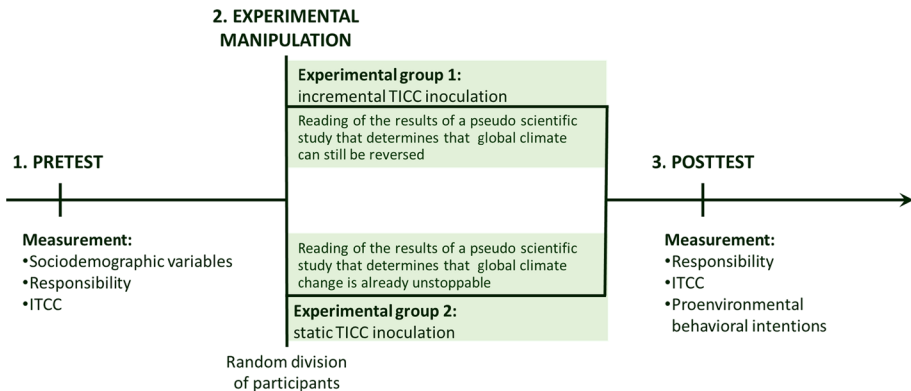


Fig. 2 Schematic representation of the procedure

carried out by an ostensible research team in the environmental field and published in a renowned scientific journal. The texts were the same except that for G1 the prestigious scientific group concluded that climate change is still reversible and that individual and collective actions could facilitate that reversibility (instilling incremental ITCC on the participants); in contrast, for G2 the prestigious scientific group concluded that climate change was now irreversible and individual and collective actions could not change this fact (instilling static ITCC on the participants).

An online questionnaire was administered to participants two weeks before (pretest) and just after manipulation (posttest) to explore their sense of responsibility toward climate change and their ITCC. Moreover, in the posttest phase, their pro-environmental behavioral intention was also measured through the personal interest shown in participating in an alleged environmental activity that involved picking up trash and cleaning riverbanks in their city.

Two weeks after having completed the pretest, a different link was sent to the participants randomly assigned to G1 and G2, to complete the test and posttest phases. The links for G1 and G2 included the experimental manipulation for instilling incremental ITCC and static ITCC, respectively. Immediately after reading the assigned article, all participants completed the posttest questionnaire.

Following these steps, the participants were fully debriefed about the real purposes of the study and the experimental procedure. They were also informed about the fictional nature of the scientific articles they had read, as well as the riverbank cleaning activities.

2.2 Participants

The participants were 48 psychology students (79.2% women, 20.8% men) of a psychology class in their first (91.7%) and second (8.3%) year of university. The mean age of the sample was 19.17 years, with a standard deviation of 1.87 and an age range of 17–25 years. According to Gall et al. (1996), there should be at least 15 participants in the experimental

groups for comparison. In this case, one class group was sufficient to perform the experiment.

2.3 Measurements

2.3.1 Responsibility toward climate change

To measure responsibility toward climate change, we used the three items of the scale developed by Kellstedt et al. (2008), to which we added three items of our own creation (scale items are shown in Table 1) to improve the reliability of the original scale. The participants answered the six items on a five-point Likert scale, where 1 = *Totally disagree* and 5 = *Totally agree*. The reliability of the scale was high both before ($\alpha=0.78$) and after ($\alpha=0.84$) the experimental manipulation.

2.3.2 Implicit theories about climate change

To measure the type of IT shown by the participants in the questionnaires, a brief seven-item ad hoc scale was designed. Four items were designed to reflect a static view about climate change and three to reflect an incremental view (the items of the scale and its subscale are shown in Table 2). The participants answered on a five-point Likert scale, where 1 = *Totally disagree* and 5 = *Totally agree*. The reliability of the ITCC subscale was high both before (static ITCC: $\alpha=0.89$; incremental ITCC: $\alpha=0.76$) and after (static ITCC: $\alpha=0.90$; incremental ITCC: $\alpha=0.88$) the experimental manipulation. Explanatory factorial analyses performed with Oblimin direct rotation showed the two expected factors both before and after the experimental manipulation. The two factors explained 72.66% of the variance before the manipulation and 78.68% after the manipulation. All the items were properly loaded on their proposed dimension, with Factor 1 corresponding to static ITCC and Factor 2 to incremental ITCC (see Table 2).

2.3.3 Pro-environmental behavioral intention

To measure the extent to which participants had the intention to adopt pro-environmental behaviors, they were asked if they wanted to participate in an alleged pro-environmental activity (without knowing that it was fictional). At the end of the posttest survey, students were informed that their university was collaborating with a prestigious nonprofit, nongovernmental organization for environmental defense that was currently carrying out a campaign to clean up the rivers around their city, and that they could voluntarily participate

Table 1 Items of the Responsibility Toward Climate Change Scale

1	I believe that my actions have an influence on global warming and climate change
2	My actions to reduce the effects of global warming and climate change in my community will encourage others to reduce the effects of global warming through their own actions
3	Humans are responsible for global warming and climate change
4	I have part of the responsibility for global warming and climate change
5	Through my actions I can influence global warming and climate change to get better or worse
6	Human beings can stop global warming and climate change through their actions if they want to

Table 2 Items of the Implicit Theories About Climate Change Scale and Explanatory Factorial Analyses results

	Higher loading for each one of the two factors			
	Before experimental manipulation		After experimental manipulation	
	Factor 1 (Static ITCC)	Factor 2 (Incr. ITCC)	Factor 1 (Static ITCC)	Factor 2 (Incr. ITCC)
1. It is now impossible to reverse the effects of global warming and climate change	.911		.912	
2. Climate change and global warming are already irreversible phenomena	.899		.962	
3. The global warming process that the planet is undergoing is already unstoppable	.901		.854	
4. By changing our behavior and habits, we can still curb the effects of global warming and climate change		.781		.810
5. A social change that implies less pollution and more ecological behavior will make it possible to reverse or stop global warming and climate change		.801		.736
6. There is nothing we can do anymore to stop climate change and global warming	.761		.855	
7. If individuals and big industries take action to reduce greenhouse gases, then global warming and climate change could be slowed		.776		.892
Percentage of explained variance	53.89	18.77	64.31	14.37

Static ITCC = static implicit theories about climate change; Incr. ITCC = incremental implicit theories about climate change

in this campaign, indicating in the survey the number of days (from zero to seven) they wanted to participate. The selection of a greater number of days indicated a higher level of pro-environmental behavioral intention.

2.4 Data analysis

To verify the effect of the experimental manipulation, a one-way analysis of variance (ANOVA) was performed, introducing the experimental group as the factor and incremental and static ITCC before and after experimental manipulation as dependent variables (DVs).

To verify the effect of ITCC on pro-environmental behavioral intention, a one-way ANOVA was performed, introducing the experimental group as the factor and pro-environmental behavioral intention as the DV.

To evaluate the moderation hypothesis, a moderation analysis was performed, using Model 1 of the Process macro for SPSS (Hayes & Preacher, 2013), with 10,000 repeated bootstrap samples and a 95% confidence interval. Pro-environmental behavioral intention was introduced as the DV, responsibility toward climate change as an independent variable (IV) and the experimental group as a moderating variable (MV), coded as -0.50 for static and 0.05 for incremental ITCC.

3 Results

3.1 Effects of experimental manipulation

The one-way ANOVA showed no significant differences in incremental [$F(1,46)=0.410$; $p=0.525$, $\eta^2=0.01$; observed power (OP)=0.10] or static [$F(1,46)=2.060$; $p=0.158$, $\eta^2=0.04$; OP=0.29] ITCC between the two experimental groups before manipulation (Fig. 3). However, after experimental manipulation, the results showed significant differences in incremental [$F(1,47)=7.923$; $p<0.01$, $\eta^2=0.15$; OP=0.79] and static ITCC [$F(1,47)=8.834$; $p<0.01$, $\eta^2=0.16$; OP=0.83], thus confirming the effectiveness of the experimental manipulation. These results are similar to previous studies that have used the same experimental manipulation in another field of research and have found that their manipulation on IT successfully changed the IT (Bauer & Hannover, 2020).

3.2 Effect of manipulation on pro-environmental behavioral intention

The one-way ANOVA performed with pro-environmental behavioral intention as a DV and experimental group as a factor showed significant differences between G1 and G2 [$F(1,47)=4.206$, $p<0.05$, $\eta^2=0.08$, OP=0.52], thus confirming H1 (Fig. 4).

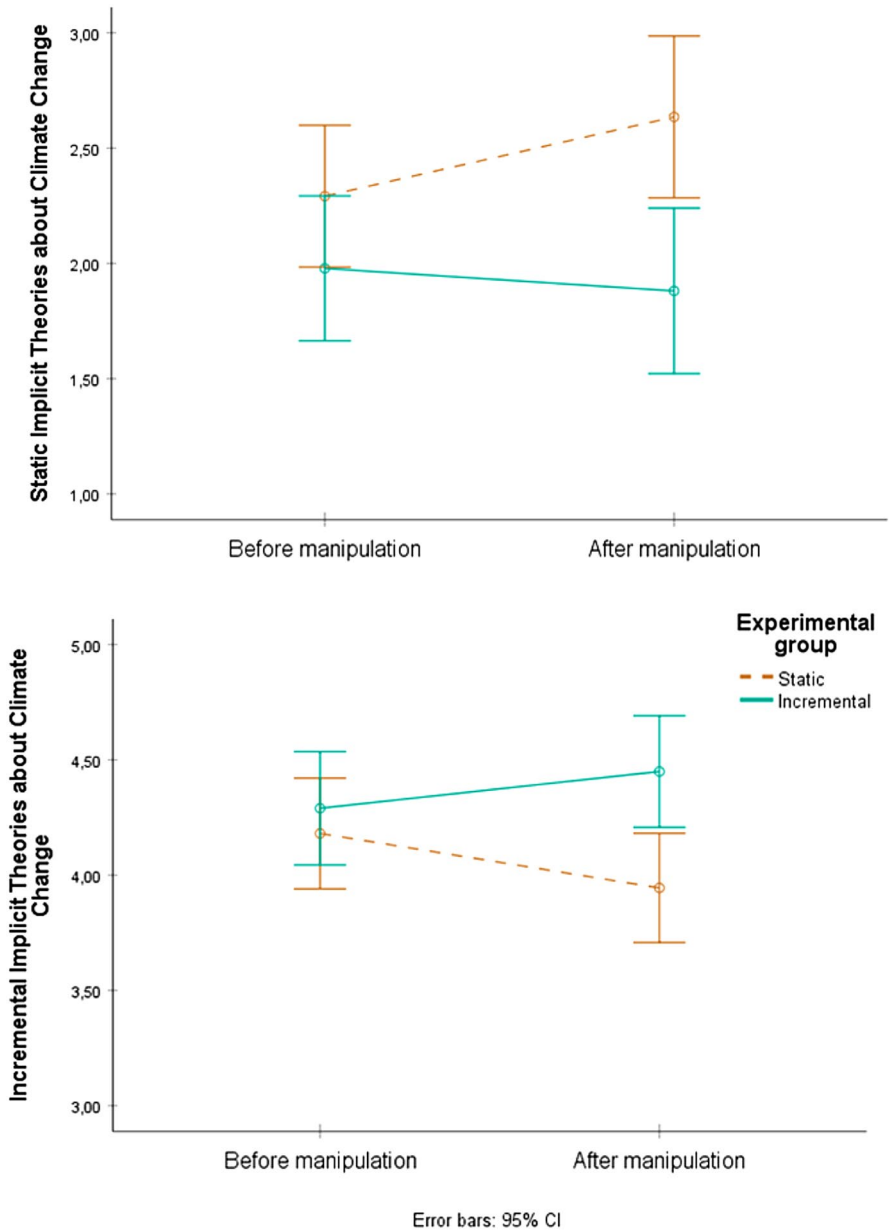


Fig. 3 Static and Incremental Implicit Theories of Climate Change (ITCC) Before and After Manipulation in the Two Experimental Groups. Note: CI=confidence interval

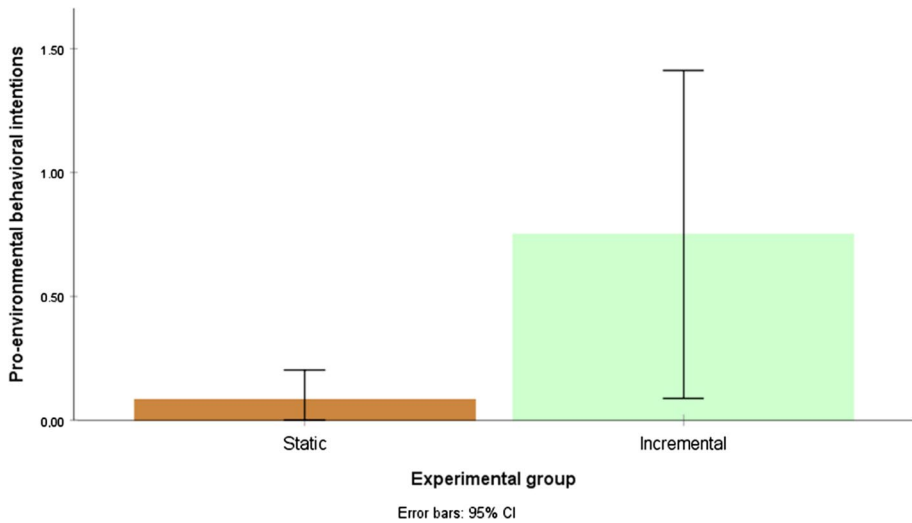


Fig. 4 Pro-Environmental Behavioral Intention for the Two Experimental Groups. *Note:* CI=confidence interval

Table 3 Coefficients of the Moderation Models for Hypothesis 2, With Implicit Theories About Climate Change as a Moderating Variable in the Relationship Between Perceived Responsibility Toward Climate Change and Pro-Environmental Behavioral Intention

		Coeff	SE	<i>p</i> [LLCI, ULCI]
Constant	i1	-1.973	1.128	.088 [-4.25, 0.31]
X (Responsibility)	b1	0.536	0.260	.046 [0.01, 1.06]
M (ITCC)	b2	-3.726	2.257	.107 [-8.29, 0.84]
XM (Responsibility x ITCC)	b3	0.977	0.521	.068 [-0.08, 2.03]
		$R^2 = .25$ $F(3,39) = 4.350$, $p = .010$	$\Delta R^2 = .068$ $F(1,39) = 3.519$, $p = .068$	

X independent variable; *M* moderator; *Y* dependent variable; *ITCC* implicit theories about climate change; *Coeff* Coefficient; *SE* standard error; *LLCI* lower-level confidence interval; *ULCI* upper-level confidence interval

3.3 Moderating effect of implicit theories of global warming in the relationship between responsibility and pro-environmental behavior

The moderating analyses showed that the interaction effect (Table 3) between the level of responsibility and the experimental group was only marginal. However, the simple effect of the level of responsibility perceived toward climate change was statistically significant for the incremental experimental group but not for the static experimental group (Table 4 and Fig. 5). Thus, H2 is confirmed, according to which the perception of responsibility toward climate change influences the pro-environmental behavioral intention of individuals in a different way, depending on whether climate change is perceived as reversible (incremental ITCC) or not (static ITCC).

Table 4 Conditional effect of responsibility toward climate change on pro-environmental behavioral intention according to the experimental group values

Experimental group	Effect	SE	p [LLCI,ULCI]
Static (-0.50)	0.047	.41	.908 [-0.78, 0.87]
Incremental (0.50)	1.024	.33	<.01 [0.37, 1.68]

SE standard error; LLCI lower-level confidence interval; ULCI upper-level confidence interval

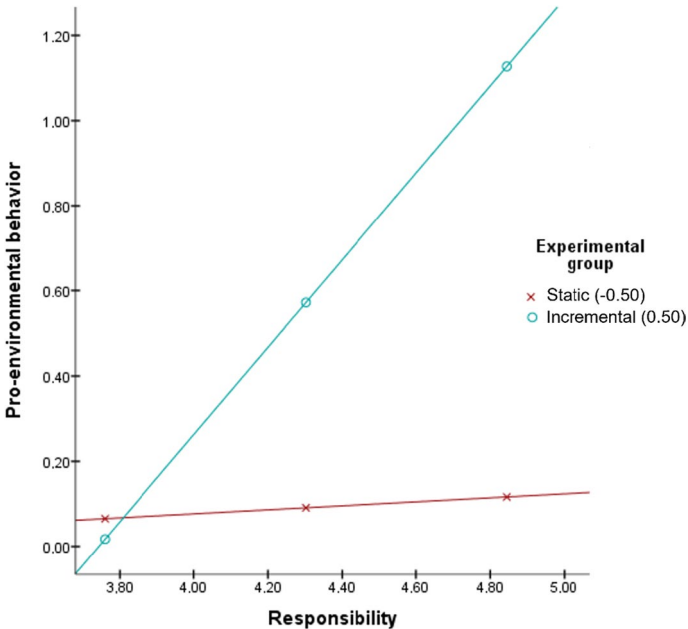


Fig. 5 Environmental Behavior Versus Responsibility in the Two Experimental Groups: Induced Static Implicit Theories About Climate Change (Red) and Induced Incremental Implicit Theories About Climate Change (green)

4 Discussion

There is practically a consensus in society that climate change is one of the most worrying global environmental issues, based on scientific evidence for its current consequences and potential risk (Yuan et al., 2017). Education is a key tool for facing this issue (Ledley et al., 2017; Monroe et al., 2019). Indeed, inclusive and equitable quality education is one of the main goals in the 2030 Agenda for Sustainable Development (United Nations, 2015). This bestows great responsibility on educational institutions and educators to convey the support and contributions that can be made from this field.

Our data analysis showed that ITCC seem to be a potentially powerful ally for educational work on environmental awareness. This study’s results show that the beliefs that individuals have regarding the reversibility of climate change can condition their pro-environmental behavioral intentions, which is a relevant predictor of pro-environmental behavior (Ajzen, 2020). The results demonstrated that people with incremental ITCC presented

a greater intention to behave in a pro-environmental way than individuals with static ITCC. These results can be explained, as claimed by Dweck and other researchers (Chiu et al., 1997; Dweck et al., 1995; Dweck & Leggett, 1988; Dweck & Yeager, 2021), because IT about the world create a conceptual framework on which to base decisions and behaviors, by leading individuals with incremental IT to mastery-oriented behavioral patterns and individuals with static IT to passive avoidance-oriented behavioral patterns. In this sense, believing that climate change is malleable and modifiable makes individuals more prone to adopt mastery-oriented pro-environmental behavior patterns and more prone to participate in environmental care activities. Putting those results in the light of the 2030 Agenda for Sustainable Development (United Nations, 2015) seems to be relevant. Developers of policies and educational programs oriented to the promotion of sustainable development should consider the relevance of promoting and instilling in people and pupils the malleable view of climate change to achieve the promotion of pro-environmental behavioral intentions and behaviors in individuals and communities, and in this way favoring the 2030 Agenda for Sustainable Development goals (United Nations, 2015).

These results are especially relevant if we consider that the malleability of ITCC can be induced in people. In this sense, our results have corroborated the effectiveness of the manipulation. After manipulation, the levels of static and incremental ITCC were higher in the group in which they had been induced. This fact shows not only the effectiveness of experimental manipulation but also that our own beliefs about the malleability of climate change can be induced by different mechanisms. At the practical level, these results indicate that catastrophic environmental awareness practices and information regarding the irreversibility of climate change should be avoided. If the idea that there is nothing we can do to avoid environmental disasters is generated in the population, then unwanted static IT will be induced, along with the negative consequences on pro-environmental behavioral intentions found in this study. Moreover, considering that our results have demonstrated that ITCC can be modified with experimental manipulation, it would be interesting to encourage direct efforts in environmental education programs toward the development of incremental ITCC, which would lead to more pro-environmental behavior intentions in individuals.

The results of this study confirmed that the perception of responsibility toward climate change influences pro-environmental intentions in a different way depending on whether individuals perceive climate change to be reversible or not. Congruent with previous research, the more individuals feel responsible for climate change, the more they tend to behave in a pro-environmental way (Attaran & Celik, 2015; Fielding & Head, 2012; Reese & Jacob, 2015; Wang et al., 2011). Nevertheless, the novelty of the results of this study is that the effect of responsibility on the intention to behave in a pro-environmental way is different in individuals who believe that climate change is reversible than in individuals who believe that it is irreversible.

Specifically, the results showed that the levels of perceived responsibility toward climate change do not influence people's intentions to behave in a pro-environmental way when they have static ITCC; on the contrary, for individuals with incremental ITCC, the more they feel responsible toward climate change, the more they have the intention to behave in a pro-environmental way. Thus, ITCC act as a moderator and seem to be a relevant key for individuals to develop pro-environmental behaviors, by influencing the relationship between responsibility and pro-environmental intention. These results are in line with previous research showing that IT act as moderators in the relationship between different variables in other research fields (Butler, 2000; Knee et al., 2004; Yung-Jui & Ying-Yi, 2010).

Thus, incremental ITCC could be a relevant protective factor for pro-environmental behavioral intentions, whereas static ITCC is a risk factor that hinders the implementation

of pro-environmental behavior even if individuals feel responsible for climate change. With static ITCC, regardless of the degree of responsibility felt by individuals, if they perceive that climate change is no longer reversible then few actions will be carried out to try to change this fact. Thus, once again it seems fundamental, from the psychoeducational interventions in the field of environmental education, not only to promote the feeling of responsibility for climate change and environmental protection but also to promote incremental ITCC—a noncatastrophic vision of the possibility of change—to encourage individuals to take pro-environmental action.

4.1 Limitations and future research

Although the research results are promising, some limitations are worth noting. First, the sample was limited in size and comprised entirely of students, which limits the possibility of generalizing the research to the global population. Therefore, it would be interesting to replicate this study in a more heterogeneous and larger sample, to observe whether the results found here are generalizable and to compare age groups and other variables to observe possible different behavior patterns between groups. Nonetheless, there is no reason to think that the relations between variables would be different in the student and global population. On the other hand, this study is representative of the behavior of the young population, so the conclusions could be applicable to this population group.

Another limitation is the greater percentage of women in the participant sample, which is a characteristic of the degree course from which the data were taken. Therefore, it would be interesting in future studies to replicate this experiment in a more homogeneous sample regarding gender in order to avoid possible bias due to this variable. Moreover, future research with larger and more heterogeneous samples could segregate the results by gender to explore any differences between men and women.

Likewise, it could be interesting to include other variables, as well as their interactions with the variables explored here, for a more complex and complete pro-environmental behavioral intention model. Also, because our research was carried out prior to the COVID-19 pandemic, it would be pertinent to consider the dynamics that could bring this actual scenario into new research on this field.

It should be noted that previous research has actually found that people with malleable views about the world reported being more willing to engage in pro-environmental behaviors (Duchi et al., 2020; Soliman & Wilson, 2017). The results of the present research not only support prior findings but also add more insights to the field, and also introduce an experimental methodology to find ways to improve environmental behaviors through the induction of malleable implicit theories about climate change.

This is an opportunity to develop new research lines in the field of environmental education, given the importance of learning how the way information is received by people can mold our daily actions, as well as the responsibility of educational institutions and educators to ensure the quality of this information.

4.2 Implications and policy recommendations

The results confirm that individuals with incremental ITCC present greater intention to behave in a pro-environmental way, and they also confirm an interaction effect of

responsibility and ITCC to predict individuals' pro-environmental behavioral intention. Together, these results highlight the relevance of promoting incremental ITCC in environmental education programs. In this sense, the results indicate the relevance of the transmission of positive public messages regarding the possibility of overcoming climate change, thus promoting the induction of incremental ITCC to improve pro-environmental behavior in society. Environmental educators must be aware that their pupils' inherent beliefs can be modified by veering away from catastrophism regarding climate change. Also, educators must disclose information on the reversibility of climate change and global warming—in short, to instill incremental ITCC—so that the sense of individual responsibility can improve overall social pro-environmental behavior. All these actions must aim to support and attain the U.N. Sustainable Development Goals from the 2030 Agenda.

4.3 Conclusions

The main aim of this pretest–posttest study was to explore how the sense of responsibility toward climate change and ITCC interact to explain pro-environmental behavior. The results showed that people with incremental ITCC are more prone to behave in a pro-environmental way than individuals with static ITCC: the results of the one-way ANOVA showed that people with incremental ITCC presented a greater intention to behave in a pro-environmental way than individuals with static ITCC. Moreover, the sense of responsibility was shown to predict the intention to behave in a pro-environmental way only in individuals with incremental ITCC, but not in individuals with static ITCC: the moderating analysis showed that ITCC act as a moderating variable in the relationship between the sense of responsibility and pro-environmental behavioral intentions. The sense of responsibility predicted pro-environmental behavioral intention when individuals hold incremental ITCC but not when they hold static ITCC. Thus, one relevant conclusion is that a sense of responsibility is one of the relevant factors for the promotion of pro-environmental intentions and actions in individuals and societies; however, this is not enough, as shown by the moderating effect of ITCC. In addition to this sense of responsibility, it is also necessary for individuals to perceive that these actions will achieve change, understanding that climate change and global warming can be stopped through individual and collective action.

Appendix

Article Extract Presented in The Posttest Questionnaire to Instill Incremental and Static Implicit Theories About Climate Change (ITCC).

Appendix 1a: Article Extract to Instill Incremental ITCC

Text presented in the posttest questionnaire given to the research participants, in which an extract from a newspaper article is presented that defends the reversibility of climate change to inoculate incremental ITCC:

Climate change: the point of no return was not reached

Results of the Climate Dynamic Research Group published in the high-impact scientific journal *Environmental Reviews*



Polar bears drifting on melting icebergs.

The scientific community is unanimous: climate change is a fact. While there has been no doubt about the existence of global warming and climate change for a long time, until recently the controversy was whether such climate change was irreversible, or whether there was still the possibility of stopping it by changing the behaviors of individuals and of the societies. However, it seems that a recent scientific study has finally resolved this question.

Indeed, the Research Group 'Climate Dynamics Group' of the Department of Atmospheric, Oceanic and Planetary Physics of the University of Oxford, led by a professor in the scientific branch of climatology, Myles Allen, has published on October 25, in the high-impact scientific journal 'Environmental Reviews', an article that leaves no room for doubt, and determines that global change can still be reversed.

The conclusions of the study, based on exhaustive statistical and climatological calculations, are conclusive and clear: Human beings can still slow down the global warming of the planet. The study determines that to curb climate change, both the small individual actions of the citizen (such as recycling, making less use of motor vehicles, or stopping dumping plastics into the environment), as well as the possible actions to reduce greenhouse gases or the polluting effects of large industries, count to stop global warming. We have not yet reached a point of no return; if individuals, industries and societies take action and act, we still have time to stop global warming. The climate change process is still reversible, and it is in the hand of the human being to achieve this fact if he takes the reins and acts accordingly, minimizing its environmental impact.

“Human beings can still slow down the global warming of the planet. to curb climate change, both the small individual actions of the citizen and the possible actions to reduce greenhouse gases or the polluting effects of large industries count to stop global warming”

- Myles Allen -

Appendix 1b: Article Extract to Instill Static ITCC

Text presented in the posttest questionnaire given to the research participants, in which an extract from a newspaper article is presented that defends the irreversibility of climate change to instill static ITCC:

Climate change: point of no return was reached

Results of the Climate Dynamic Research Group published in the high impact scientific journal *Environmental Reviews*



Polar bears drifting on melting icebergs.

The scientific community is unanimous: climate change is a fact. While there has been no doubt about the existence of global warming and climate change for a long time, until recently the controversy was whether such climate change was irreversible, or whether there was still the possibility of stopping it by changing the behaviors of individuals and of the societies. However, it seems that a recent scientific study has finally resolved this question.

Indeed, the Research Group 'Climate Dynamics Group' of the Department of Atmospheric, Oceanic and Planetary Physics of the University of Oxford, led by a professor in the scientific branch of climatology, Myles Allen, has published on October 25, in the high-impact scientific journal 'Environmental Reviews', an article that leaves no room for doubt, and determines that global change is already unstoppable.

The conclusions of the study, based on exhaustive statistical and climatological calculations, are conclusive and clear: there is nothing that humans can do to stop global warming on the planet. Neither the small individual actions of the citizen (such as recycling, making less use of motor vehicles, or stopping dumping plastics into the environment), nor the possible actions to reduce greenhouse gases or the polluting effects of large industries will be enough to stop global warming. We have already reached a point of no return where neither individual action nor those of industries or societies will have an effect. The climate change process is already unstoppable, and human beings can no longer do anything to change this fact.

“There is nothing that humans can do to stop global warming on the planet. Neither the small individual actions of the citizen nor the possible actions to reduce greenhouse gases or the polluting effects of large industries will be enough to stop global warming”

- Myles Allen -

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. Funding for open access charge: Universidad de Córdoba / CBUA

Data availability statement Data will be available on Cuadrado, Esther (2022), "Implicit theories about climate change malleability and proenvironmental behavioral intentions" Mendeley Data, V1, doi: 10.17632/cpfm8v6bwr.1.

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