



# How a growth mindset can change the climate: The power of implicit beliefs in influencing people's view and action



Lorenzo Duchi<sup>a,\*</sup>, Doug Lombardi<sup>b</sup>, Fred Paas<sup>a,c</sup>, Sofie M.M. Loyens<sup>a,d</sup>

<sup>a</sup> Department of Psychology, Education, and Child Studies, Erasmus University Rotterdam, the Netherlands

<sup>b</sup> College of Education, University of Maryland, United States

<sup>c</sup> School of Education/Early Start, University of Wollongong, Australia

<sup>d</sup> Utrecht University, University College Roosevelt, the Netherlands

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## ABSTRACT

Although people seem to be concerned about climate change, few are pro-actively engaged in attempting to mitigate it. This discrepancy between environmental view and action has been recognized as a great challenge. This empirical study examined that disparity by investigating people's mindsets about the world. Such mindsets concern the degree to which people perceive their world as a changeable entity that can be shaped (growth mindset) rather than a static one that cannot be moulded or changed (fixed mindset). A survey conducted with American adults explored how these different mindsets could impact 1) attitudes towards climate change, 2) beliefs about its mitigation, 3) pro-environmental behavioural inclinations and 4) the self-reported frequency of pro-environmental actions. Holding a growth mindset about the world was related to more accepting attitudes towards climate change, more favourable beliefs about its possible mitigation, and greater pro-environmental behavioural inclinations. In addition, growth mindset was positively related to higher values in attitudes, beliefs, and behavioural inclinations people experienced after reading a persuasive and informative text on climate change. Finally, ten days later, participants with a stronger view that the world is changeable reported having engaged more frequently in pro-environmental actions throughout those ten days. Overall, holding a growth mindset might help to overcome some of the psychological barriers to environmental action.

## 1. Introduction

The existence and worsening of human-caused climate change are overwhelmingly clear. This alarming news not only comes from the work of researchers and academics (Intergovernmental Panel on Climate Change, 2007; Kolbert, 2014; Oreskes & Conway, 2014; Pearce et al., 2017; Van der Linden et al., 2015), but was also announced by 100 Nobel Laureates, who claimed climate change to be a danger to world peace (Nobel Laureates, 2001). Interestingly, while the majority of people know and are concerned about human-caused climate change, only one in ten believes in the possibility of successfully mitigating it (Leiserowitz et al., 2017; Pew Research Center, 2017).

This divergence between people's high level of concern and knowledge about climate change, on the one hand, and their lack of pro-environmental actions, on the other hand, has been recognized as a great challenge in tackling environmental issues (Gifford, 2011). Although there is a large body of research studying such relations

(Gifford, 2011; Heath & Gifford, 2006; Hidalgo & Pisano, 2010; Milfont & Page, 2013; O'Connor et al., 1999; Swim et al., 2009; Van der Linden et al., 2015), little is known about the determinants of pro-environmental actions (Brody et al., 2008; Hornsey et al., 2016; Kahan et al., 2011; Kellstedt et al., 2008; Panno et al., 2015; Pidgeon, 2012; Slovic, 2000). Research shows that pro-environmental action is impacted more by similar values, political orientations, and personal experiences than by being exposed to scientific observations, such as greenhouse gas concentration or global climate models (Dessai et al., 2004; Gifford, 2011; Hamilton, 2011; Kahan et al., 2011; Kollmuss & Agyeman, 2002; Pearce et al., 2017; Pidgeon, 2012; Price et al., 2014; Weber, 2010). Consequently, it is pivotal to understand whether and how specific psychological factors may enhance pro-environmental behaviours, hopefully providing insights into the discrepancy between environmental view and action.

In particular, people's implicit beliefs about the changeability of our world could impact their environmental view and action (Soliman &

\* Corresponding author. Department of Psychology, Education, and Child Studies, Erasmus University Rotterdam, Burgemeester Oudlaan 50, Rotterdam, 3062, PA, the Netherlands.

E-mail address: [duchi@eur.nl](mailto:duchi@eur.nl) (L. Duchi).

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Wilson, 2017). Such implicit beliefs are able to create a worldview that colour people's perceptions and have been shown to have powerful explanatory power in many behavioural domains, from school to work-related contexts (Blackwell et al., 2007; Burnette et al., 2013; Dweck & Leggett, 1988; Hong et al., 1999). Therefore, people's implicit beliefs (i.e., incremental beliefs or a growth mindset) concerning the degree to which the world is perceived to be a fluid and malleable entity that can be shaped or improved, rather than a static one that cannot be moulded or changed (i.e., entity beliefs or a fixed mindset), may underlie their environmental view and action.

However, these different mindsets have not been examined extensively in the environmental realm. Thus far, only Soliman and Wilson (2017) have examined how such mindsets impact environmental view and action. They found that a fixed mindset about the world was negatively associated with people's willingness to engage in pro-environmental behaviours. Contrastingly, a growth mindset about the world was positively associated with such an inclination. Importantly, this relation was largely mediated by people's level of scepticism about climate change and their views regarding the possibility of successfully mitigating climate change. Those who thought the world to be relatively stable were less likely to engage in pro-environmental actions because they were more likely to be sceptical about climate change and less likely to believe that society will be able to avert the consequences of climate change.

This present study extended the research of Soliman and Wilson (2017) in two ways. First, we explored how mindsets related to people's environmental views and actions after having read a persuasive and informative text. Second, we endeavoured to extend previous research by moving beyond measuring people's intentions to engage in pro-environmental behaviours to measuring behaviours. Thus, we investigated how different mindsets affected the self-reported frequency of pro-environmental behaviours.

Prior to reporting the specifics of the present study, we first discuss prior environmental education research, which served as the rationale for our investigation. We introduce theoretical foundations concerning growth and fixed mindsets and how such beliefs create a 'meaning system' through which people perceive the world. This provides the basis for our examination of how such beliefs could be related to climate change-related view and action.

### 1.1. Environmental education research: Responsible environmental behaviour

The research conducted on determinants of pro-environmental behaviours, from saving energy to recycling, has been defined as responsible environmental behaviours (REB). The first meta-analysis on REB research was conducted by Hines et al. (1986/87), which showed the relations between internal psychological constructs such as feelings and beliefs, pro-environmental attitudes and intentions, and pro-environmental behaviours.

With the recognition of the pivotal role of psychological drivers on pro-environmental behaviour, researchers have continued to study psycho-social determinants of REB. To summarize the large amount of studies being published in this area, many meta-analyses have been conducted to improve on Hines et al. (1986/87) by postulating integrated models of the psycho-social determinant of REB (Bamberg & Möser, 2007; Jackson, 2005; Klöckner, 2013). Overall, these studies have converged upon the idea that internal psychological constructs determine people's attitudes, which in turn, affects their pro-environmental intentions and actions (i.e., acting as critical drivers for REB).

In the present study, we followed the line of reasoning highlighted by the past 30 years of research conducted on REB. We have extended this research by exploring the links between internal psychological constructs, attitudes, pro-environmental intentions, and pro-environmental behaviour. We also have introduced a new determinant of REB, growth and fixed mindsets, which have received much attention in

other areas of psychological research.

### 1.2. Mindsets: Growth vs fixed

Dweck's theory of implicit beliefs (Dweck & Leggett, 1988) described two types of beliefs, entity and incremental, both of which tend to remain subconscious and unacknowledged by the person. An entity belief (or fixed mindset) about, for example, a human attribute such as intelligence characterizes such an attribute as being unchangeable and fixed while an incremental belief (or growth mindset) would describe the same attribute as being changeable and improvable. There is a large body of literature showing the impact that such mindsets have on the way people perceive and interpret the qualities of individuals, groups and the world around themselves (Dweck & Leggett, 1988; Hong et al., 1999; Soliman & Wilson, 2017).

For instance, at the individual level, mindsets impact motivation, academic achievements, procrastination, and other outcomes differently (Blackwell et al., 2007; Burnette et al., 2013; Chen & Pajares, 2010; Howell & Buro, 2009; Sisk et al., 2018). When encountering setbacks, for example, people who view their intelligence as fixed tend to attribute such failures to a lack of ability and would react by feeling a sense of helplessness, withdrawing or being petrified. Yet, people who view their intelligence as malleable tend to make fewer helpless attributions and to invest more effort or change approach in response to failures (Blackwell et al., 2007; Burnette et al., 2013). In particular, it seems that these mindsets set up different frameworks, or 'meaning system,' that guide people's attributions and behaviours (Dweck & Leggett, 1988; Hong et al., 1999; Molden & Dweck, 2006; Tempelaar et al., 2015). For instance, growth and fixed mindsets about intelligence influence academic performance and self-esteem through a network of goals, beliefs, and strategies that stemmed from these beliefs (Blackwell et al., 2007; Burnette et al., 2013; Chen & Pajares, 2010; Robins & Pals, 2002).

A growth mindset has been found to affect how people interpret the world around them for a large variety of people, from youth, children, and students to workers, managers, and athletes (Blackwell et al., 2007; Burnette et al., 2013; Chen & Pajares, 2010; Heslin & VandeWalle, 2008; Schumann & Dweck, 2014; Stenling et al., 2014). It has been shown that internalizing a growth mindset buffers the negative consequences that people with low socio-economic backgrounds and minorities suffer in school (Claro et al., 2016; Eom et al., 2018; Good et al., 2003; Sisk et al., 2018). Interestingly, evidence shows that it is possible to shift from a fixed to a growth mindset (Blackwell et al., 2007; Good et al., 2003; Schumann & Dweck, 2014). For example, it has been found that exposing Israelis and Palestinians to research findings that explain how the nature of groups in general is malleable (vs fixed) and can (vs cannot) be changed improved their attitudes towards one another and enhanced their willingness to compromise and work together (Wohl et al., 2015). Therefore, growth and fixed mindsets not only impact one's life, but can also have repercussions on larger societal issues.

Could mindsets then impact the way people perceive and interpret the qualities of the world around them? Given the 'meaning system' they create, such mindsets may well play a role in how people approach climate change. In particular, people's mindsets concerning the degree to which the world is perceived to be a fluid and malleable entity that can be shaped or improved (i.e. growth mindset about the world), rather than a static one that cannot be moulded or changed (i.e. fixed mindset about the world), may underlie their environmental view and action. If the world, at core, is viewed as fixed and static, having ingrained dispositions that cannot be shaped, the problem of climate change might look less possible and real, inhibiting the motivation to engage in pro-environmental behaviour. Conversely, a growth mindset about the nature of the world, which is perceived as being malleable that can be shaped and improved, could help us to be more resilient and adequately respond to it. This is what Soliman and Wilson (2017) have

begun to discover.

Therefore, given the large body of research presented above and, specifically, the work of [Soliman and Wilson \(2017\)](#), we expected that people's mindsets about the world would impact their environmental view and action. In particular, we expected that they would impact how people evaluate the problem (i.e., people's attitudes towards climate change) how they think about the solution (i.e., beliefs about the mitigation of climate change), how they are inclined to act (i.e. pro-environmental behavioural inclinations) and how they act (i.e. self-reported pro-environmental behaviour). Therefore, examining such mindsets may enhance our understanding of the psychological barriers to pro-environmental action as well as of the discrepancy in the general population between their informed view on human-caused climate change and their lack of environmental action.

### 1.3. View on climate change

#### 1.3.1. Attitudes towards climate change

The degree of concern and knowledge towards climate change has risen for the past decade and people have started to see it as a major threat ([Eurobarometer, 2019](#); [Pew Research Center, 2019](#)). Yet, a large number of people are still in denial about the severity of and need for action on human-caused climate change ([Hornsey et al., 2016](#); [Leiserowitz et al., 2017](#); [Pew Research Center, 2017](#)). People's denial reveals itself in many different ways. Few people actually make it a priority. Although the majority of people claim the governments are not doing enough to reduce the effects of climate change, only one in four says they always live in harmony with the environment ([Pew Research Center, 2019](#)). Furthermore, partisanship is a stronger factor in people's understanding about climate change than their level of knowledge ([Kollmuss & Agyeman, 2002](#); [Leiserowitz et al., 2017](#); [Pew Research Center, 2019](#); [Pidgeon, 2012](#)).

Therefore, it is highly relevant to examine the variables associated with people's attitudes towards human-caused climate change. We expected that growth and fixed mindsets about the world would be related to such environmental attitudes, given that [Soliman and Wilson \(2017\)](#) found a relation between growth and fixed mindsets about the world and people's level of scepticism in regards to climate change. Individuals who think that the world is relatively stable might be more likely to perceive the forecasts of a changing planet due to climate change as incompatible with their mindsets and therefore as less plausible.

#### 1.3.2. Beliefs about the mitigation of climate change

Because the scale of the problem may look overwhelming ([Klein, 2014](#); [Oreskes & Conway, 2014](#)), it is understandable that only a small proportion of people believe that we can successfully overcome climate change ([Leiserowitz et al., 2017](#); [Pew Research Center, 2017](#)). However, evidence shows that believing in the possibility that change can happen and that developing solutions can be possible is a prerequisite for the willingness to act in the context of climate change ([Heath & Gifford, 2006](#); [Hidalgo & Pisano, 2010](#); [Kellstedt et al., 2008](#); [O' Connor et al., 1999](#)). As [Soliman and Wilson \(2017\)](#) showed, people's growth and fixed mindsets can subtly yet substantially impact their beliefs in the possibility of mitigating climate change. If one sees the world as stable, one is less likely to believe in actions that supposedly could create significant changes in such a world. Therefore, we expected that growth and fixed mindsets about the world would predict people's beliefs about successful mitigation of climate change. In particular, we expected people who hold a fixed mindset not to believe that actions could be taken to avert the negative consequences of climate change, possibly undermining their behavioural inclinations.

### 1.4. Action on climate change

#### 1.4.1. Behavioural inclinations

Interest in pro-environmental behaviour is strong in the literature (e.g., [Gifford, 2011](#); [Heath & Gifford, 2006](#); [Hidalgo & Pisano, 2010](#); [Milfont & Page, 2013](#); [O' Connor et al., 1999](#); [Swim et al., 2009](#)). As [Stern \(2000\)](#) demonstrated, there are different types of environmentally significant behaviours. He, for instance, distinguished three kinds of pro-environmental behaviours: direct and public engagement (e.g., protest), indirect and public involvement (e.g., paying extra taxes), and private participation (e.g., recycling). It is then important to take into account of the different types of pro-environmental behaviours to construct an informative overview of what is under examination. As [Soliman and Wilson \(2017\)](#) demonstrated, holding a fixed mindset had a negative indirect influence on people's inclinations to engage in different types of pro-environmental behaviours via their influence on people's level of scepticism about climate change and their views regarding the possibility of successfully mitigating it. Therefore, we expected that holding a fixed mindset would be associated with weaker pro-environmental behavioural inclinations due to people's less accepting attitudes towards the problem and less favourable beliefs about the solution.

#### 1.4.2. Pro-environmental actions

Although many facets of environmental behaviour have been accounted for, the majority of studies in this area have evaluated only the willingness to engage in pro-environmental behaviour, rather than real behaviour ([Price et al., 2014](#); [Sinatra et al., 2012](#); [Soliman & Wilson, 2017](#)). Therefore, in order to foster better understanding of what drives pro-environmental actions, a focus on self-reported frequency of behaviours (rather than only different types of behavioural inclinations) is needed. Given the 'meaning framework' that such mindsets create, which then has an impact on one's life ([Hong et al., 1999](#)), we expected that growth and fixed mindsets about the world would be indirectly associated with people's self-reported frequency of pro-environmental actions through their influence on attitudes towards climate change, beliefs about its successful mitigation, and behavioural inclinations. That is, we expected that holding a fixed mindset about the world would predict lower frequency of pro-environmental action through its negative influence on attitudes towards climate change, beliefs about its successful mitigation, and behavioural inclinations.

### 1.5. Changes in attitudes, beliefs, and behavioural inclinations

Climate change is a multi-faceted problem that is encountered in many different scenarios, such as home, work, and school ([Klein, 2014](#)). Climate change will cause substantial changes in our environment and will require considerable shifts in our lives ([Klein, 2014](#); [Oreskes & Conway, 2014](#); [Swim et al., 2009](#)). How can people change their understanding and behaviour related to climate change in response to such encounters? What are the features that facilitate these changes? [Sinatra et al. \(2012\)](#) examined attitude and behavioural changes in the context of climate change. They showed that attitudes and behavioural inclinations towards pro-environmental actions improved after having read a persuasive and informative text. Moreover, approaching ideas in an open-minded fashion and enjoying effortful thinking predicted such changes. Will growth and fixed mindsets be able to influence those changes as well? Given that such mindsets shape how we approach difficult situations ([Blackwell et al., 2007](#); [Burnette et al., 2013](#); [Chen & Pajares, 2010](#)), they might affect people's experience when reading a persuasive text concerning climate change. Holding a fixed mindset about the world might push people to discard easily the information provided in the text, as such information would conflict with their fixed mindset about a stable world. The present study therefore examined how growth and fixed mindsets about the world predicted attitudes towards climate change, beliefs about its successful mitigation, and

behavioural inclinations that people will possess after reading a persuasive text. We expected that the stronger the fixed mindset, the lower the values in attitudes, beliefs, and behavioural inclinations after reading the text.

### 1.6. Present study

The present study built on the work of Soliman and Wilson (2017) and Sinatra et al. (2012). It examined the relations among growth and fixed mindsets about the world and people's attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations towards addressing climate change, similarly to how Soliman and Wilson (2017) explored it. In addition, such attitudes, beliefs, and behavioural inclinations were measured both before and after the presentation of a persuasive text about climate change, as adopted by Sinatra et al. (2012). In this way, we were able to explore how growth and fixed mindsets about the world would predict people's attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations after having read such a text. We also examined how these mindsets would affect frequency of self-reported behaviours, a limitation of their work discussed by both Sinatra et al. (2012) and Soliman and Wilson (2017). To do so, at the end of the first session (T1) participants were asked to identify four "new" pro-environmental behaviours they would like to undertake in the following days/weeks. Ten days afterwards (T2), participants' self-reported frequency of engagement in their "new" desired behaviours was measured (see Procedure 2.3).

#### 1.6.1. Hypotheses

The following hypotheses were formulated:

- 1 In line with Sinatra et al. (2012), we expected that there would be a significant improvement in attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations from before to after reading the persuasive text on climate change.
- 2 We predicted growth and fixed mindsets would be related to attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations towards climate change before reading the text. Based on Soliman and Wilson (2017), we expected that:
  - a The stronger the fixed (vs. growth) mindset a person has, the less (vs. more) accepting the attitudes towards human-induced climate change, the less (vs. more) favourable beliefs about its mitigation, and the lower (vs. greater) behavioural inclinations a person would experience;
  - b The relation between fixed mindset and behavioural inclinations would be indirect, completely mediated by attitudes towards climate change and beliefs about its mitigation.
- 3 Following the findings of Sinatra et al. (2012), we expected fixed mindset to indirectly predict people's attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations after reading the text. In particular, the stronger the fixed (vs. growth) mindset about the world, the smaller (vs. larger) the values in attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations after reading the text.
- 4 We predicted that fixed mindset would be associated with the level of self-reported frequency of behaviours measured at T2. We expected that holding stronger fixed (vs. growth) mindset about the world would be related to a lower (vs. higher) frequency of engagement in "novel" behaviours. Given the 'meaning system' such mindsets create, we expected this relation to be indirect, completely mediated by attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations measured after reading the text at T1.

#### 1.6.2. Models

While Hypothesis 1 was tested by conducting paired sample *t*-tests,

two models were constructed in order to test the remaining hypotheses. The first model (Model 1) was necessary to examine Hypothesis 2, how fixed mindset relate to one's attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations, and Hypothesis 3, how fixed mindset predict people's attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations after reading the text. Based on existing research and the theoretical rationale outlined above, Model 1, shown in Fig. 1 was developed. Model 2, shown in Fig. 2, was necessary to examine Hypothesis 4: that is, how fixed mindset relates to self-reported frequency of behaviours measured at T2.

## 2. Method

### 2.1. Participants

We recruited our sample via Amazon Mechanical Turk (MTurk). We decided on a sample of around 300 people to reflect the choice made by Soliman and Wilson (2017), whose study's design resembles the present one with regard to the medium utilized (i.e., MTurk) and the topic examined (i.e., growth and fixed mindsets). Our final sample included 301 participants, most of whom were male (54%) and white (78.4%). The other ethnicities were Hispanic (4.3%), African American (8.6%), Asian (6.3%), and Other (2.3%). Participants' ages ranged from 18 to 75 years ( $M = 38$ ,  $SD = 11.4$ ) and most participants (74%) possessed either a bachelor's degree or a similar qualification. The remaining participants had a high school diploma or less (13%) or a post-graduate degree (13%). The participants' family annual household income was distributed evenly across seven categories, ranging from earning less than \$15,000 to more than \$100,00. Lastly, 52.5% were either strong, somewhat, or only leaning towards being Democrats while 25% were either strong, somewhat, or only leaning towards being Republicans. The remaining 22% saw themselves as independent.

Ten days after completing the first session (T1), participants were sent a reminder to complete the follow-up (T2). A total of 107 participants completed the follow-up and did not differ from the people who did not take part in the follow-up regarding their fixed mindset, age, educational level, race/ethnicity, or political orientation. Yet, they differed in gender,  $\chi^2(1) = 5.76$ ,  $p = .02$ , with more female participants taking part in the T2 measurements, and in family annual household income,  $\chi^2(7) = 14.73$ ,  $p = .04$ , with more people with higher incomes taking part at T2.

### 2.2. Materials

#### 2.2.1. Mindsets

Given the scope of climate change, we followed the same consideration that Soliman and Wilson (2017) had in adopting the original three-item scale of the different mindsets about the world developed by Chiu et al. (1997). Those items were: 1) "Our world has its basic or ingrained dispositions, and you really can't do much to change them"; 2) "Though we can change some phenomena, it is unlikely that we can alter the core dispositions of our world"; and 3) "Some societal trends may dominate for a while but the fundamental nature of our world is something that cannot be changed much."<sup>1</sup> Items were rated on a six-point Likert scale ranging from 1 = strongly disagree to 6 = strongly agree. The higher the scores, the stronger the fixed mindset and the weaker the growth one.

<sup>1</sup> Items are framed from a fixed perspective in order to avoid socially desirable responses, as people are more likely to give such responses when the items are framed from a growth point of view. This is only possible because fixed and growth views lie at the opposite ends of the same continuum (Chiu et al., 1997).

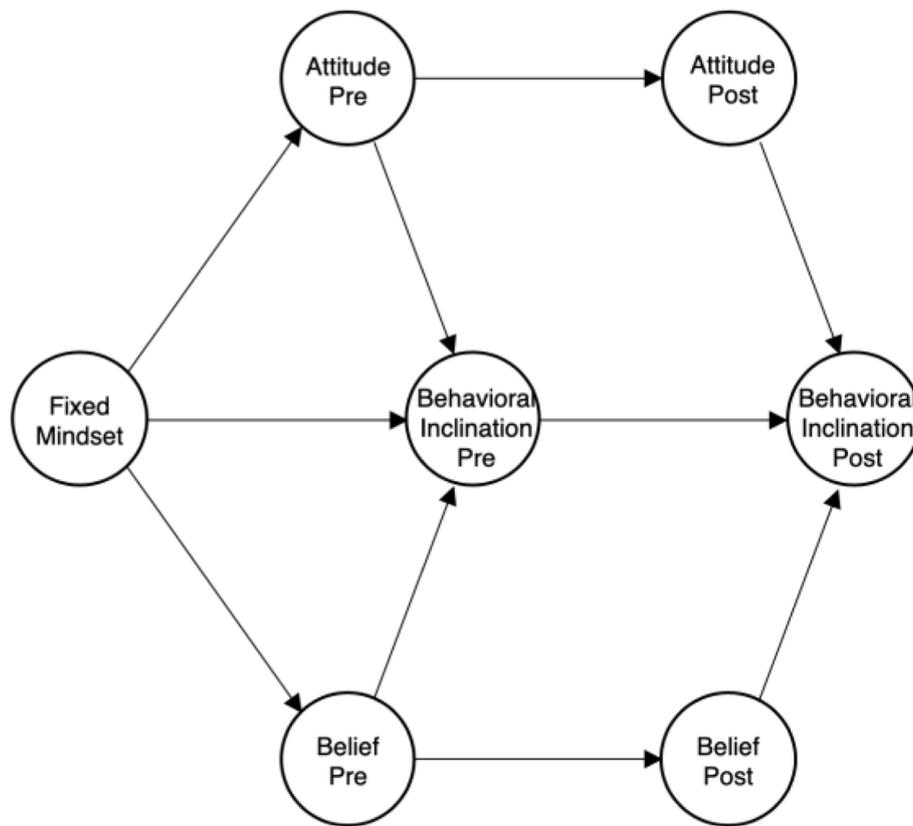


Fig. 1. Model 1 showing attitude, belief and behavioural inclination before and after reading the persuasive text with fixed mindset as the main predictor.

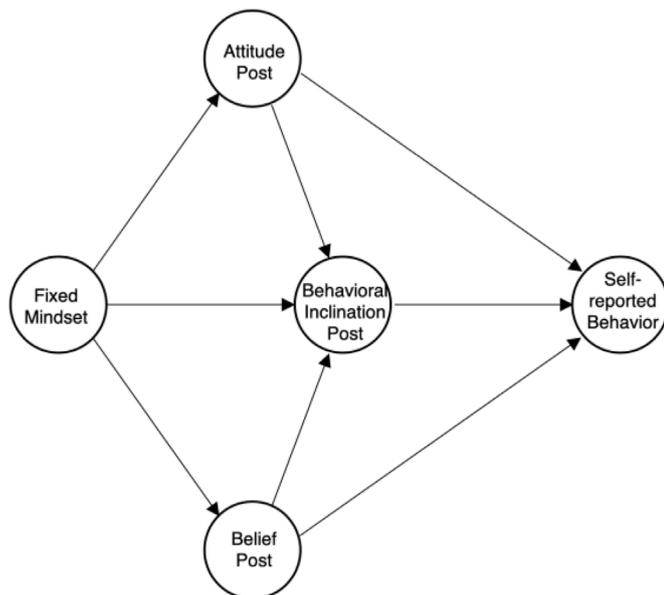


Fig. 2. Model 2 examining the impact of self-reported behaviour measured at T2 via attitude, belief, behavioural inclination measured after the text.

2.2.2. Attitude towards climate change

The five-point Likert scale (1 = strongly disagree, 5 = strongly agree) measure used in Sinatra et al. (2012) was used to examine participants’ attitudes and understanding of the problem of climate change (see Appendix A). The scale was based on conclusions of the Intergovernmental Panel on Climate Change (2007) as reported in the text participants were instructed to read.

2.2.3. Beliefs about the mitigation of climate change

The measure assessing belief about the mitigation of climate change introduced by Soliman and Wilson (2017) was administered (responses ranged from 1 = strongly disagree to 7 = strongly agree). It has three items: 1) “I feel that by engaging in environmentally sustainable behaviours, I can make a difference in mitigating climate change”; 2) “I feel like any action I take to be environmentally responsible is only a ‘drop in the bucket’ and won’t make a difference” (reversed scoring); and 3) “I believe that by engaging in environmentally sustainable behaviours, I encourage or inspire others to do likewise”.

2.2.4. Behaviour questionnaire

Inclinations regarding pro-environmental behaviour were measured using the scale developed by Soliman and Wilson (2017). This scale examines inclination to engage in different types of pro-environmental behaviours in line with Stern’s (2000) multi-facet behavioural clusters (1 = very unlikely, 5 = very likely). See Appendix A for the full scale. The overall score from the scale is considered in this study, although it is composed of four subscales (1) environmentally-responsible behaviours (12 behaviours; e.g., “reducing the amount of beef eaten”), (2) gathering sustainability-related information (3 behaviours, e.g., “read an environmental magazine”), (3) engagement via social media (2 behaviours; e.g., “share information about the environment on social media such as Facebook or Twitter”), and (4) collective action/major decisions (5 behaviours; e.g., “join environmental action groups”).

2.2.5. Self-reported behaviour

Participants were asked to write down four “novel” pro-environmental behaviours they themselves would like to try and undertake. They could have chosen behaviours from the behaviour questionnaire or come up with their own. Ten days later, they had to report with a five-point Likert scale (1 = never, 5 = every time) the frequency with which they engaged in for each of their “new” pro-environmental

behaviours.

2.2.6. Text

The persuasive text of the present study was the same text used in the study by Sinatra et al. (2012) derived from an article published on February 3, 2007 in The New York Times (Stevens, 2007). The text dealt with the development of our understanding behind climate change. It was 1123 words in length, with a readability score of 12.2 on the Flesch Kincaid Index, indicating a required level of reading grade 12 or higher in order to understand it. Only a few sentences were adjusted to make it more actual. For instance, “Even conservative presidential candidate John McCain of Arizona has asserted that the argument about whether global warming is occurring is over” was replaced by “Even the president of France, Emmanuel Macron, has disclosed to the U.S. Congress that the argument about whether global warming is occurring is over”.

2.3. Procedure

2.3.1. Pre-test

Participants were invited to take part in a survey on climate change. Once participants decided to partake in the survey, they were asked to report on some demographic variables (i.e., age, gender, ethnicity, educational level, and political affiliation) as well as to complete the questionnaire regarding their mindsets about the world. Then, they were administered the questionnaires concerning their attitudes about climate change, beliefs about its mitigation, and behavioural inclinations.

2.3.2. Intervention

Participants then read the persuasive text at their own pace. A provocative image that appeared in the original New York Times article, which showed the globe being heated by a torch, was added to the test and was clearly designed to be attention grabbing and persuasive.

2.3.3. Post-test

After having read the text, participants retook the questionnaires on attitudes, beliefs, and behavioural inclinations towards climate change. Next, they were asked to write down four “novel” pro-environmental behaviours they themselves would like to try and undertake in the following days/weeks.

2.3.4. Follow-up test

Ten days later, participants were asked to report how frequently they had engaged in their “new” pro-environmental behaviours.

2.4. Data analysis

We performed a partial least squares SEM analysis with the software

program Smart PLS 3. We followed the multi-stage procedure outlined by Hair et al. (2017) when conducting PLS-SEM analyses to evaluate the results, which requires first an evaluation of the measurement model (see sections 3.2.1.1 and 3.2.2.1) and only subsequently of the structural model (see sections 3.2.1.2 and 3.2.2.2). In the present study, as we used scales to assess the latent variables, we dealt with reflective measurement models.

Evaluation of reflective measurement models includes internal consistency reliability, convergent, and discriminant validity. When these evaluation criteria have been met, one can examine the structural model, which represents the underlying structural concepts of the path model. This assessment provides information about the model’s ability to predict the target construct(s). Since the focus of PLS-SEM is on prediction rather than on explanatory modelling, evaluation of the fit offers little value and “can even be harmful as researchers may be tempted to sacrifice predictive power to achieve better fit” (Hair et al., 2017, p. 204). Therefore, Hair et al. (2017) strongly advised against using such fit statistics in this context. Instead of assessing goodness-of-fit, the structural model is evaluated on the basis of criteria that determine how well the models predict the constructs, which include collinearity, significance of the path coefficients, level of the R<sup>2</sup> values, and the f<sup>2</sup> effect size.

Mediation analysis was needed to test hypotheses 2b, 3 and 4. Following the rationale of Hair et al. (2017), bootstrapped indirect effects were utilized to test for mediation instead of using tests such as the Sobel test. In terms of size and influence of the standardized path values, the criteria recommended by Keith (1993) were followed: standardized path coefficients ranging from 0.05 to 0.10 are small, but meaningful, influences; from 0.11 to 0.25 are medium in size and influence; and above 0.25 are large in size and influence. As for the f<sup>2</sup> effect size, values of 0.02, 0.15, and 0.35 are considered to represent small, medium, and large effects of the independent latent variable, respectively (Cohen, 1988).

3. Results

3.1. Preliminary analyses

Scores that fell above or below the mean by more than three standard deviations were considered outliers. The results of the following analyses will, thus, be conducted without the presence of such outliers. In order to reduce the degrees of freedom in analysing the data and to make the results more transparent, the analyses will also be conducted with the presence of such outliers, shown in Appendix B. The composite scores for all the variables were computed. Table 1 reports their mean, standard deviation, range, skewness, kurtosis, and reliability.

We conducted statistical tests to detect possible differences in mindsets across the different demographic variables. Significant differences were found only for the variables of age and political

**Table 1**  
Descriptive statistics of the composite scores for the most important variables.

		N		Std. Deviation	Range		Skewness	Kurtosis	Coefficient H
		Mean	Std. Error		Min	Max			
Fixed mindset		301	3.56	.072	1.249	1 6	-.165	-.892	.96
Pre	Attitude towards problem	298	4.03	.041	0.709	1.85 5	-.799	.075	.95
	Beliefs about mitigation	301	5.02	.072	1.253	1.33 7	-.575	-.094	.89
	Behavioural inclinations	301	3.56	.039	.669	1.59 5	-.398	.115	.93
Post	Attitude towards problem	295	4.31	.036	.61	2.31 5	-1.147	.776	.95
	Beliefs about mitigation	299	5.23	.075	1.302	1.33 7	-.714	.065	.90
	Behavioural inclinations	299	3.71	.039	.679	1.64 5	-.524	.151	.93
Follow	Self-reported behaviours	103	3.53	.055	.563	2.25 4.75	.278	-.258	.76

**Table 2**  
Correlations Between the Composite Variables Under Examination Before and After Reading the Text as well as at the Follow-up.

		1	2	3	4	5	6	7
Pre	1. Fixed mindset							
	2. Attitudes towards problem	-.353 <sup>a</sup>						
	3. Beliefs about mitigation	-.351 <sup>a</sup>	.496 <sup>a</sup>					
Post	4. Behavioural inclinations	-.298 <sup>a</sup>	.514 <sup>a</sup>	.589 <sup>a</sup>				
	5. Attitudes towards problem	-.293 <sup>a</sup>	.819 <sup>a</sup>	.396 <sup>a</sup>	.424 <sup>a</sup>			
	6. Beliefs about mitigation	-.322 <sup>a</sup>	.464 <sup>a</sup>	.818 <sup>a</sup>	.573 <sup>a</sup>	.451 <sup>a</sup>		
Follow	7. Behavioural inclinations	-.313 <sup>a</sup>	.520 <sup>a</sup>	.569 <sup>a</sup>	.943 <sup>a</sup>	.459 <sup>a</sup>	.618 <sup>a</sup>	
	8. Self-reported behaviours	-.099	.115	.165	.251 <sup>b</sup>	.104	.238 <sup>b</sup>	.193

<sup>a</sup> Correlation is significant at the 0.01 level (2-tailed).

<sup>b</sup> Correlation is significant at the 0.05 level (2-tailed).

affiliation: being older was associated with holding a fixed mindset ( $r = 0.206, p < .001$ ); and being a Republican was more likely to be related with holding a fixed mindset than being a Democrat,  $F(7, 293) = 9.264, p < .001, \eta_p^2 = 0.18$ . Table 2 presents the inter-correlations between the variables relevant for answering the hypotheses.

We examined whether the persuasive text induced the expected changes in attitudes towards climate change, beliefs about its mitigation, and behavioural inclinations. By conducting repeated measures ANOVAs, Hypothesis 1 was supported. In particular, differences in attitudes towards climate change were statistically significant,  $F(1, 293) = 130.38, p < .001, \eta_p^2 = 0.308$ , such that people experienced a more accepting attitude toward human-induced climate change from before ( $M = 4.06, SD = 0.68$ ) to after ( $M = 4.32, SD = 0.60$ ) reading the text. Moreover, there was a statistically significant change in the beliefs about the mitigation of climate change,  $F(1, 298) = 18.09, p < .001, \eta_p^2 = 0.057$ , with more favourable beliefs post-reading ( $M = 5.23, SD = 1.30$ ) than pre-reading ( $M = 5.04, SD = 1.23$ ). Similarly, differences in behavioural inclinations were also detected,  $F(1, 298) = 117.04, p < .001, \eta_p^2 = 0.282$ , such that these inclinations were enhanced after the presentation of the text ( $M = 3.71, SD = 0.68$ ) compared to before ( $M = 3.57, SD = 0.65$ ). See Appendix C for a graphical representation with error bars of the pre- and post-reading scores of the dependent variables.

### 3.2. Structural equation modeling (SEM)

#### 3.2.1. Model 1: Mindsets on attitude, belief, and behavioural inclination before and after reading the text

3.2.1.1. Model evaluation. In order to assess the measurement model, the first criterion to be evaluated is internal consistency reliability. Cronbach's alpha is the default option provided by Smart PLS 3 and what Hair et al. (2017) suggest. However, for assessing the reliability of latent constructs in the context of SEM, coefficient H has been highly recommended (Hancock & Mueller, 2001). Thus, coefficient H was used to examine the reliability of the variables under examination, as shown in Table 1. Second, to examine convergent validity, the average variance extracted (AVE) was considered, which should be higher than 0.50. Given that the AVE was lower than 0.50 for the variables of attitudes towards climate change and behavioural inclinations, an examination of the outer loadings was required. While outer loadings higher than 0.70 are desirable and lower than 0.40 must be eliminated, one should carefully examine the outer loadings with values between 0.40 and 0.70 (Hair et al., 2017). Specifically, indicators with outer loadings between 0.40 and 0.70 should be removed only when deleting such indicators leads to an increase in the reliability or the AVE without impacting the content validity. For the variable of attitudes towards climate change, eliminating the item "The speed with which the melting ice caps may raise sea levels is uncertain", whose outer

loading was lower than 0.40, boosted the AVE above the threshold of 0.50. The reliability of this measurement was not affected. As for the variable of behavioural inclinations, by deleting seven items (three with outer loadings lower than 0.40 and four with outer loadings below 0.50) the AVE reached the threshold required. The items deleted stemmed from the 12-item sub-scale reflecting environmentally-responsible behaviours. This procedure did not impact the content validity, as there were still five items assessing this sub-scale, which was still as large as the second largest sub-sale. See Appendix A for a detailed list of the items that have been deleted. The coefficient H for this measurement dropped from 0.95 to 0.93. Table 1 shows the reliability once the items had been deleted. Third, discriminant validity was examined by looking at the heterotrait-monotrait ratio (HTMT) of the correlations. While most variables had HTMT values lower than the desired threshold of 0.90, behavioural inclinations and beliefs about the mitigation of climate change before reading the text had HTMT higher than 0.90 with behavioural inclinations and beliefs about the mitigation of climate change after reading the text, respectively. When examining the structural model, collinearity was not a critical issue, as the VIF values were clearly between the critical thresholds of 0.20 and 5.

3.2.1.2. Hypothesis testing. The direct path coefficients and their respective p-values for model 1 are visually shown in Fig. 3 and reported, with the

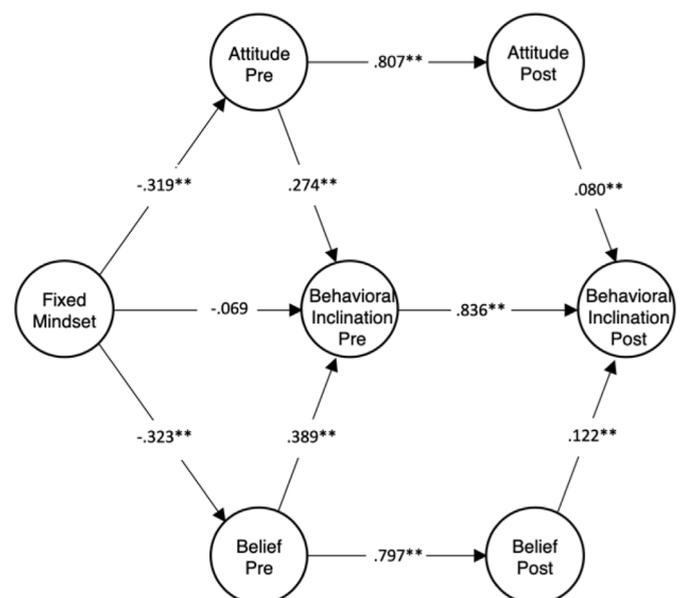
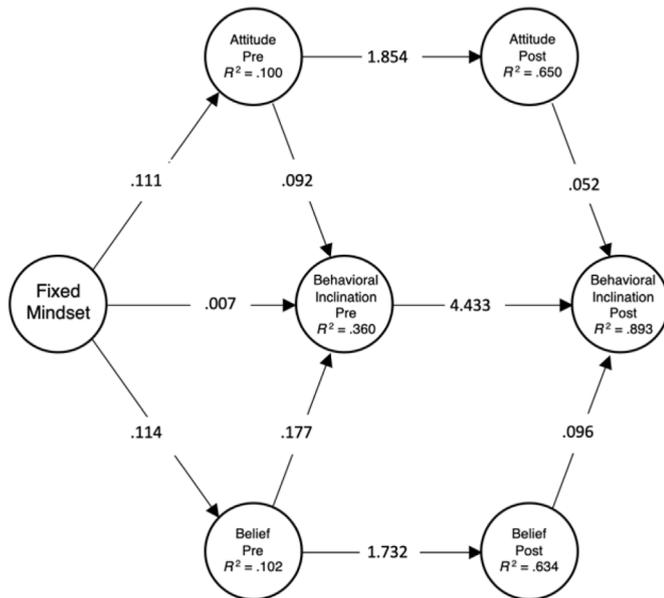


Fig. 3. Model 1 showing the direct standardized path coefficients with\*\* being significant at an  $\alpha < 0.01$ , without outliers.

**Table 3**  
Decomposition of the effects of fixed mindset in the models without outliers.

		Direct		Indirect	
		$\beta$	95% CI	$\beta$	95% CI
Pre	Attitudes towards problem	-.316 <sup>a</sup>	[-.414, -.212]		
	Beliefs towards mitigation	-.321 <sup>a</sup>	[-.428, -.206]		
	Behavioural inclinations	-.063	[-.174, .048]		
Post	Attitudes towards problem			-.217 <sup>a</sup>	[-.290, -.145]
	Beliefs towards mitigation			-.256 <sup>a</sup>	[-.345, -.164]
	Behavioural inclinations			-.286 <sup>a</sup>	[-.387, -.178]
Follow	Self-reported behaviours			-.096 <sup>b</sup>	[-.181, -.008]

<sup>a</sup>  $\beta$  is significant at the .01 level (2-tailed).  
<sup>b</sup>  $\beta$  is significant at the .05 level (2-tailed).



**Fig. 4.** Model 1 showing the direct  $f^2$  effect sizes along the arrows and the  $R^2$  values inside the circles, without liers.

indirect path coefficients and their respective confidence intervals, in Table 3. The  $R^2$  values and the  $f^2$  effect sizes are presented in Fig. 4.

Fixed mindset had a direct and statistically significant negative relation with both attitudes towards climate change ( $\beta = -0.32$ ,  $p < .01$ ,  $f^2 = 0.11$ ) and beliefs about its mitigation ( $\beta = -0.32$ ,  $p < .01$ ,  $f^2 = 0.11$ ) measured before the presentation of the text, with medium to large path coefficients and small to medium effect sizes. Thus, Hypothesis 2a was supported: holding a fixed mindset about the world was associated with less accepting attitudes towards climate change and less favourable beliefs about its mitigation. Furthermore, holding a fixed mindset about the world was indirectly and moderately related to behavioural inclinations ( $\beta = -0.22$ ,  $p < .01$ ) via attitudes towards climate change as well as beliefs about its mitigation. This supported Hypothesis 2b concerning indirect-only mediation: that is, the indirect effect was significant while the direct one was not.

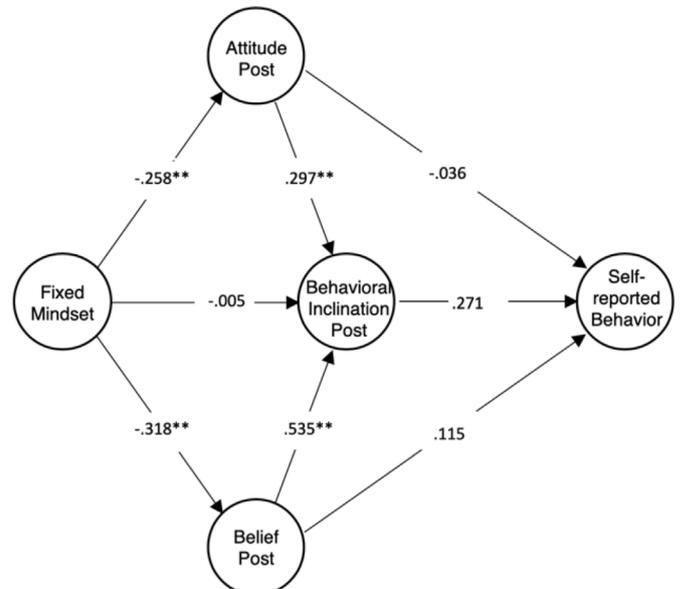
To test Hypothesis 3, we investigated the indirect paths linking fixed mindset and attitudes, beliefs, and behavioural inclinations at the post-test. Fixed mindset had a statistically significant and moderate association with attitudes ( $\beta = -0.26$ ,  $p < .01$ ), beliefs about mitigation ( $\beta = -0.26$ ,  $p < .01$ ), and behavioural inclinations ( $\beta = -0.29$ ,  $p < .01$ ) measured at post-test. Therefore, Hypothesis 3 was corroborated. That is, the stronger the fixed mindset, the smaller the post-test values in attitudes, beliefs, and behavioural inclinations people

experienced after reading a persuasive text on climate change.

**3.2.2. Model 2: Mindsets on attitudes, beliefs, behavioural inclinations, and self-reported behaviours**

**3.2.2.1. Model evaluation.** The assessment of the measurement model showed no anomalies regarding reliability and discriminant validity. However, as expected, when examining convergent validity, there were some issues with the variables of attitudes towards climate change and behavioural inclinations. Regarding the former variable, the AVE was already higher than the required 0.50. Yet, the outer loading of the same item that posed an issue in the previous model was well below 0.40. Thus, it was discarded, improving the AVE without impacting the reliability coefficient. As for the latter variable, deleting four of the seven items, which were eliminated in the previous model, with outer loadings lower than 0.50 sufficed to bring the AVE above 0.50. This lowered the coefficient H for this measurement from 0.94 to 0.93. When examining the structural model, collinearity was not a critical issue.

**3.2.2.2. Hypothesis testing.** The direct path coefficients and their respective  $p$ -values for the model are visually depicted in Fig. 5 and reported, together with the indirect path coefficients and their respective confidence intervals, in Table 3. The  $R^2$  values and the  $f^2$  effect size are presented in Fig. 6. Holding a fixed mindset had a



**Fig. 5.** Model 2 showing the direct standardized path coefficients with \*\* being significant at an  $\alpha < 0.01$ , without outliers.

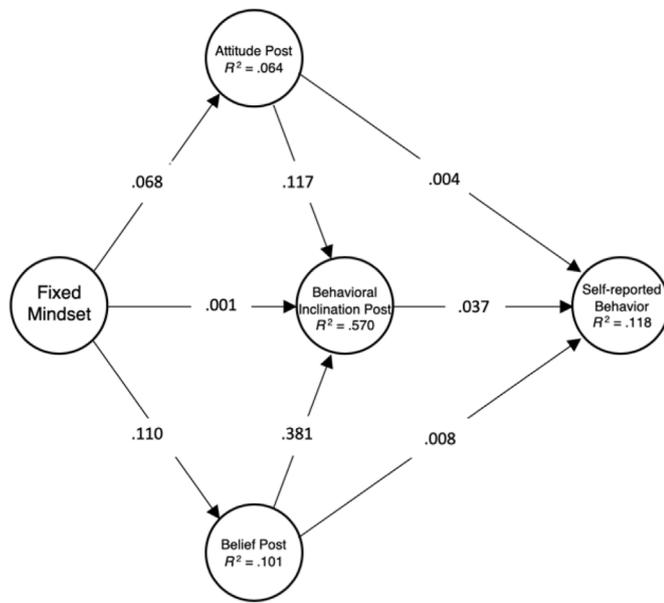


Fig. 6. Model 2 showing the direct  $f^2$  effect sizes along the arrows and the  $R^2$  values inside the circles, without outliers.

statistically significant and small indirect association ( $\beta = -0.096$ ,  $p = .033$ ) with self-reported behaviours. As expected from the indirectly mediation Hypothesis 4, fixed mindset about the world were directly associated with a lower level of self-reported behavioural engagement measured at T2, via their relation with attitudes, beliefs, and behavioural inclinations measured after reading the text at T1.

#### 4. Discussion

This study investigated the relation that fixed and growth mindsets about the world have with environmental view and action: fixed mindset about the world perceive the world and its core dispositions as being static and unchangeable, while growth mindset about the world perceive the world at its core as being a fluid substance that is malleable and can be shaped. The present study showed that fixed and growth mindsets about the world predicted attitudes towards climate change, beliefs about its successful mitigation, behavioural inclinations, and self-reported behaviours. Given that fixed and growth views lie at the opposite ends of the same continuum (Chiu et al., 1997), the results can be interpreted from the growth view perspective, although the models and analyses were built around the fixed mindset.

A growth mindset was associated with more accepting attitudes towards climate change, more favourable beliefs about its mitigation, and, indirectly, greater pro-environmental behavioural inclinations. Furthermore, people holding a growth mindset obtained higher values in attitudes, beliefs, and behavioural inclinations after reading a persuasive text on climate change in comparison to the people holding a more fixed mindset. Lastly, given the paucity of studies exploring self-reported behaviour (Sinatra et al., 2012; Soliman & Wilson, 2017), examining the frequency of self-reported behaviours allowed us to determine whether self-reported pro-environmental behaviour could be associated with one's growth mindset. Holding a growth mindset was indeed indirectly associated with a higher frequency of behavioural engagement measured 10 days later, through their relation with more accepting attitudes towards climate change, more favourable beliefs about its mitigation, and greater pro-environmental behavioural inclinations. Although a 10-day interval is too short as a delay to provide conclusions about sustained behaviour change, we believe that it was a first attempt to tackle a previously existing research gap.

#### 4.1. Limitations

Given the correlational nature of the present study and the use of SEM to analyse the data, causality cannot be inferred in the absence of experimental manipulation. It is, therefore, not possible to claim that fixed and growth mindsets about the world are causally related to people's attitudes, beliefs, behavioural inclinations, and self-reported frequency of engaging in pro-environmental behaviours. Moreover, a careful and cautious examination of the results of the follow-up is required. Considering that Model 2 was composed of five variables, the sample of one hundred people represents the bare minimum number needed to examine such model with partial least squares SEM (Schreiber et al., 2006). It is possible that the partial least squares underestimates the path coefficients when the sample size is small (Hair et al., 2017). Furthermore, the deletion of many items from the scale measuring behavioural inclinations, although required in order to reach an appropriate level of convergent validity, might have caused a bias. Lastly, the accuracy and adequacy on self-reported measurements should be taken into consideration. There has been much research highlighting the shortcomings of such method, such as the lack of introspective access (Hofmann et al., 2005) or social desirability bias (Kimberlin & Winterstein, 2008). Therefore, although self-report measurements do not have to be discarded, they can be improved (Fryer & Dinsmore, 2020; Fryer & Nakao, 2020); the current findings should be evaluated bearing in mind these weaknesses.

#### 4.2. Directions for future research

While it builds from and is consistent with previous research, the present study provides new suggestions for future research. First, the correlational nature of the present study calls for experimental manipulations in order to draw causal inferences on the relation between fixed and growth mindsets, on the one hand, and attitudes, beliefs about mitigation, and behaviours in the environmental domain, on the other hand. Research on fixed and growth mindsets in other domains (e.g. about intelligence) showed that is possible to change people's mindsets (Blackwell et al., 2007; Good et al., 2003; Schumann & Dweck, 2014). Second, while the present research found evidence for the mediating role of attitude towards climate change and beliefs about its mitigation in the relation between fixed and growth mindsets about the world and behavioural outcomes, other mediators are likely to be present. For instance, self-efficacy seems to be intertwined with those mindsets (Chen & Pajares, 2010; Chen & Usher, 2013) as well as to be related to attitudes and behaviours towards climate change (Heath & Gifford, 2006; Hidalgo & Pisano, 2010). However, no study has examined the relation between self-efficacy and fixed and growth mindsets in the context of climate change. Third, future research should reflect on the different types of changes involved in this topic, and how they relate to growth and fixed mindsets. They range from beliefs about the climate and whether it is actually changing and/or can be changed to beliefs about ourselves as to whether we can change the environment and/or change ourselves. We suggest that people's mindset about the changeability of the world relates to people's beliefs about the possibility to change and mitigate the climate. Yet, other key relations, such as how such mindset would impact the belief that people can change, are yet to be examined.

#### 5. Conclusion

The present study showed that mindset about the changeability of the world impact both people's view and action in regard to climate change. Overall, holding an fixed mindset about the world may be a significant psychological barrier to environmental action, while possessing a growth view might help to overcome inaction and to adapt to difficult changes. The current evidence suggests that these beliefs can meaningfully contribute to our understanding of the levers of both

action and inaction in the environmental domain, bringing insights concerning the gap in the general population between their informed view on human-caused climate change and their lack of environmental action.

#### Author note

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#### CRediT authorship contribution statement

**Lorenzo Duchi:** Conceptualization, Methodology, Formal analysis,

#### Appendix A

Attitudes towards the problem (Sinatra et al., 2012).

1. Scientific evidence points to a warming trend in global climate.
2. Human activity has been the driving force behind the warming trend over the last 50 years.
3. The release of CO<sub>2</sub> (carbon dioxide) from human activity (such as smokestacks and car emissions) has played a central role in raising the average surface temperature of the earth.
4. The surface temperature of the earth has risen by more than 1-degree Fahrenheit since 1900.
5. The Greenland ice cap is melting faster than had previously been thought.
6. Human activity is responsible for the continuing rise in average global temperature.
7. The speed with which the melting ice caps may raise sea levels is uncertain.
8. The likelihood that emissions are the main cause of the observed warming trend of the last 50 years is between 90 and 99%.
9. Former Vice President Al Gore's documentary, "An Inconvenient Truth," about global climate change is just propaganda.
10. Natural phenomena such as solar variations combined with volcanic activity are the real cause of the warming effect.
11. Humans have very little effect on climate temperature.
12. An increase in CO<sub>2</sub> (carbon dioxide) is directly related to an increase in global temperature.
13. It is arrogant to assume that humans can influence climate temperature.

Behavioural Inclinations (Soliman & Wilson, 2017).

1. Read a conservation or environmental magazine or electronic publication
  2. Have a serious discussion on environmental issues with friends or family members
  3. Watch a video (online or on television) about the environment
  4. Use scrap paper\*
  5. Purchase second-hand goods\*
  6. Carry a refillable coffee mug or water bottle\*
  7. Turn off lights when not in use\*
  8. Share a car journey with someone else\*
  9. Buy environmentally-friendly products
  10. Eat food which is organic, locally-grown or in season\*
  11. Purchase products with less packaging
  12. Avoid buying disposable products or choose to buy re-useable products
  13. Support a "green" company or business or avoid buying from a company with environmentally unsustainable practices
  14. Actively look for recycling bins to dispose of recyclable items\*
  15. Reduce the amount of water I use (e.g., shorter showers, not running tap water unnecessarily during toothbrushing & dishwashing, avoiding other water-wasting activities)
  16. Share information about the environment through social media (such as facebook and twitter)
  17. Participate in online groups that support environmental causes
  18. Join environmental action groups
  19. Take action by participating in protests
  20. Make voting decisions on the basis of candidates' commitment to fighting climate change
  21. Pressure my political representatives to take a stand on climate issues
  22. Weigh environmental concerns heavily when making major purchase decisions (vehicles, appliances, etc.)
- \* These items have been deleted when evaluating the measurement model.

#### Appendix B

Table B.1

Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Doug Lombardi:** Writing - review & editing. **Fred Paas:** Writing - review & editing. **Sofie M.M. Loyens:** Writing - review & editing, Supervision.

#### Declaration of competing interest

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Decomposition of the Effects of Fixed Mindset in the Models With Outliers

		Direct		Indirect	
		$\beta$	95% CI	$\beta$	95% CI
Pre	Attitudes towards problem	-.345**	[-.446, -.239]		
	Beliefs about mitigation	-.349**	[-.452, -.241]		
	Behavioural inclinations	-.051	[-.152, .051]	-.252**	[-.329, -.177]
Post	Attitudes towards problem			-.293**	[-.380, -.204]
	Beliefs about mitigation			-.291**	[-.379, -.201]
	Behavioural inclinations			-.311**	[-.407, -.208]
Follow	Self-reported behaviours			-.131*	[-.239, -.022]

\*\*  $\beta$  is significant at the .01 level (2-tailed).

\*  $\beta$  is significant at the .05 level (2-tailed).

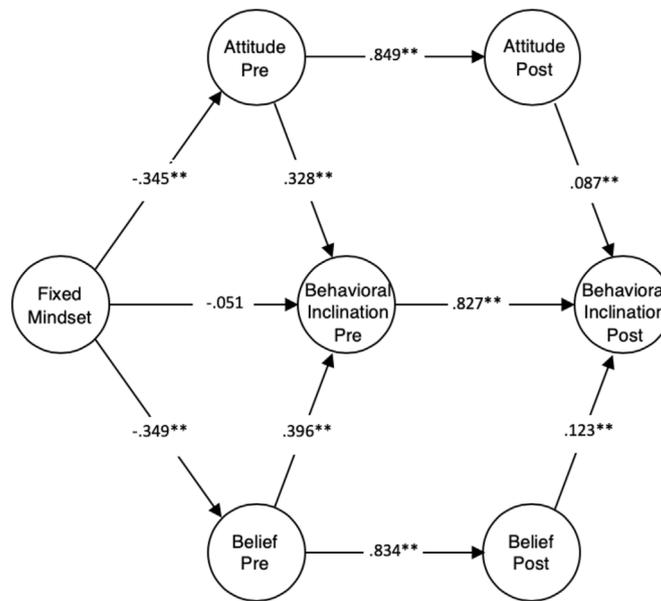


Fig. B1. 1

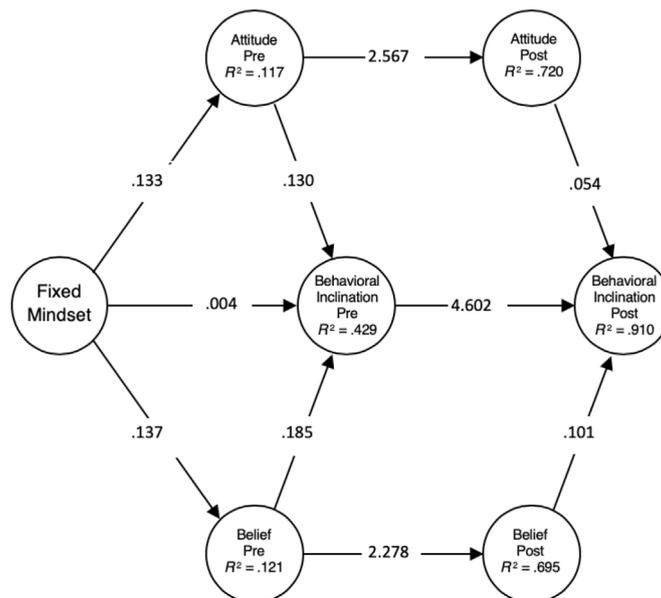


Fig. B2. 2

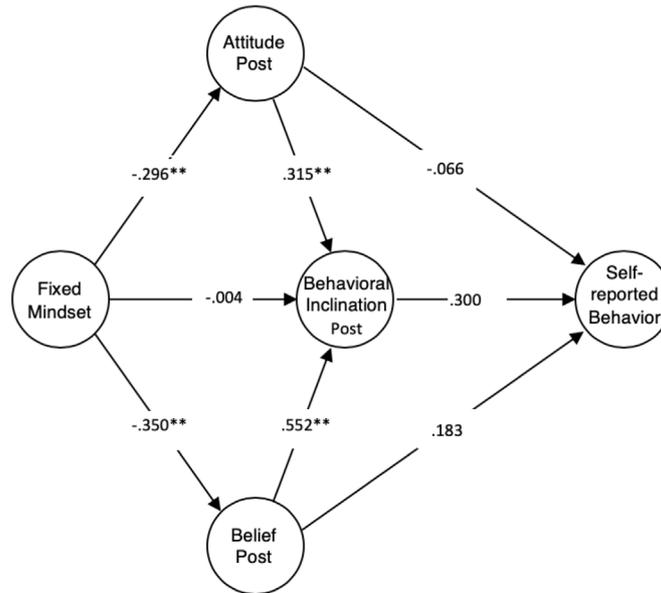


Fig. B3. 3

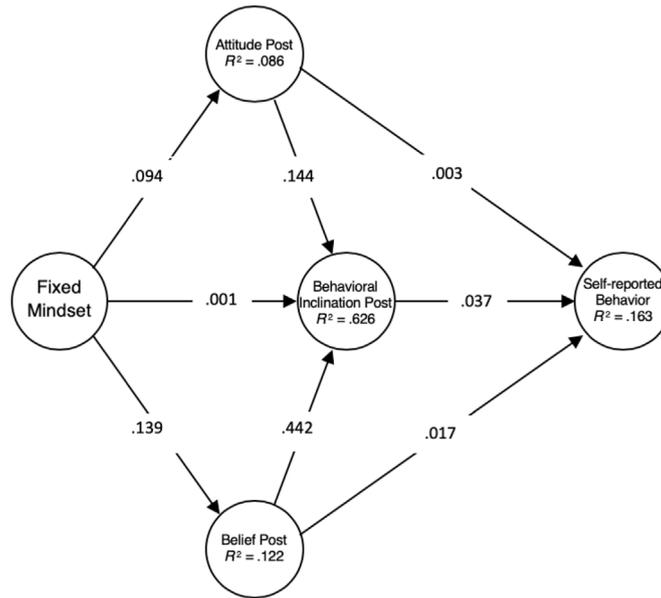


Fig. B4.

## Appendix C

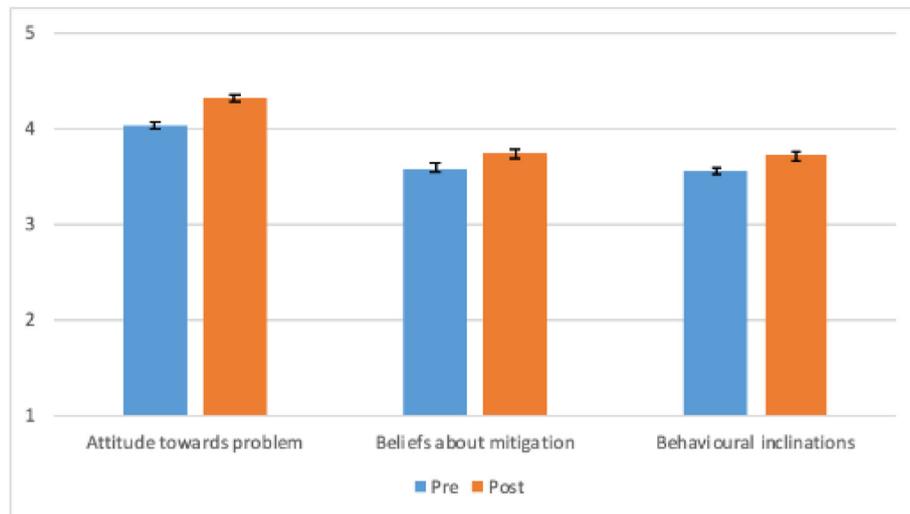


Fig. C1. Bar graph with error bars of the pre- and post-reading scores of the dependent variables. The scores were normalized to a 5-point scale to make sure all the dependent variables were represented on the same scale.

## References

- Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14–25.
- Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*(1), 246–263. <https://doi.org/10.1111/j.1467-8624.2007.00995.x>.
- Brody, S. D., Zahran, S., Vedlitz, A., & Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment and Behavior, 40*(1), 72–95.
- Burnette, J. L., O'Boyle, E. H., VanEpps, E. M., Pollack, J. M., & Finkel, E. J. (2013). Mind sets matter: A meta-analytic review of implicit theories and self-regulation. *Psychological Bulletin, 139*(3), 655–701. <https://doi.org/10.1037/a0029531>.
- Chen, J. A., & Pajares, F. (2010). Implicit theories of ability of Grade 6 science students: Relation to epistemological beliefs and academic motivation and achievement in science. *Contemporary Educational Psychology, 35*(1), 75–87. <https://doi.org/10.1016/j.cedpsych.2009.10.003>.
- Chen, J. A., & Usher, E. L. (2013). Profiles of the sources of science self-efficacy. *Learning and Individual Differences, 24*, 11–21.
- Chiu, C. Y., Dweck, C. S., Tong, J. Y. Y., & Fu, J. H. Y. (1997). Implicit theories and conceptions of morality. *Journal of Personality and Social Psychology, 73*(5), 923–940.
- Claro, S., Paunesku, D., & Dweck, C. S. (2016). Growth mindset tempers the effects of poverty on academic achievement. *Proceedings of the National Academy of Sciences, USA, 113*, 8664–8668.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum.
- Dessai, S., Adger, W. N., Hulme, M., Turnpenny, J., Köhler, J., & Warren, R. (2004). Defining and experiencing dangerous climate change. *Climatic Change, 64*(1–2), 11–25.
- Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273. <https://doi.org/10.1037/0033-295X.95.2.256>.
- Eom, K., Kim, H. S., & Sherman, D. K. (2018). Social class, control, and action: Socioeconomic status differences in antecedents of support for pro-environmental action. *Journal of Experimental Social Psychology, 77*, 60–75.
- Eurobarometer, S. (2019). Climate change. *Special Eurobarometer, 490*.
- Fryer, L. K., & Dinsmore, D. L. (2020). The promise and pitfalls of self-report. *Frontline Learning Research, 8*(3), 1–9.
- Fryer, L. K., & Nakao, K. (2020). The future of survey self-report: An experiment contrasting Likert, VAS, slide, and swipe touch interfaces. *Frontline Learning Research, 8*(3), 10–25.
- Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist, 66*(4), 290–302. <https://doi.org/10.1037/a0023566>.
- Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied Developmental Psychology, 24*(6), 645–662. <https://doi.org/10.1016/j.appdev.2003.09.002>.
- Hair, J. F., Jr., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling* (2nd ed.). Los Angeles: Sage Publications.
- Hamilton, L. C. (2011). Education, politics and opinions about climate change evidence for interaction effects. *Climatic Change, 104*(2), 231–242. <https://doi.org/10.1007/s10584-010-9957-8>.
- Hancock, G. R., & Mueller, R. O. (2001). Rethinking construct reliability. In R. Cudeck, S. du Toit, & D. Sörbom (Eds.), *Structural equation modeling: Present and future* (pp. 195–216). Lincolnwood, IL: Scientific Software International.
- Heath, Y., & Gifford, R. (2006). Free-market ideology and environmental degradation: The case of belief in global climate change. *Environment and Behavior, 38*(1), 48–71. <https://doi.org/10.1177/0013916505277998>.
- Heslin, P. A., & VandeWalle, D. (2008). Managers' implicit assumptions about personnel. *Current Directions in Psychological Science, 17*(3), 219–223.
- Hidalgo, M. C., & Pisano, I. (2010). Determinants of risk perception and willingness to tackle climate change. A pilot study. *Psychology, 1*(1), 105–112.
- Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1986/87). Analysis and synthesis of research on responsible environmental behaviour: A meta-analysis. *The Journal of Environmental Education, 18*, 1–8.
- Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta-analysis on the correlation between the Implicit Association Test and explicit self-report measures. *Personality and Social Psychology Bulletin, 31*(10), 1369–1385.
- Hong, Y. Y., Dweck, C. S., Chiu, C. Y., Lin, D. M.-S., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology, 77*(3), 588–599. <https://doi.org/10.1037/0022-3514.77.3.588>.
- Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change, 6*(6), 622–626.
- Howell, A. J., & Buro, K. (2009). Implicit beliefs, achievement goals, and procrastination: A mediational analysis. *Learning and Individual Differences, 19*(1), 151–154.
- Intergovernmental Panel on Climate Change. (2007). 4th assessment report: Synthesis report summary for policy makers. Retrieved on May 22, 2018 [https://www.ipcc.ch/publications\\_and\\_data/ar4/syr/en/spm.html](https://www.ipcc.ch/publications_and_data/ar4/syr/en/spm.html).
- Jackson, T. (2005). Motivating sustainable consumption: A review of evidence on consumer behaviour and behavioural change. *Sustainable Development Research Network, 29*, 30.
- Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147–174.
- Keith, T. Z. (1993). Causal influences on school learning. In H. J. Walberg (Ed.), *Analytic methods for educational productivity* (pp. 21–47). Greenwich, CT: JAI Press.
- Kellstedt, P. M., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis, 28*(1), 113–126.
- Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health-System Pharmacy, 65*(23), 2276–2284.
- Klein, N. (2014). *This changes everything: Capitalism vs. the climate*. New York, NY: Simon and Schuster.
- Klößner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—a meta-analysis. *Global Environmental Change, 23*(5), 1028–1038.
- Kolbert, E. (2014). *The sixth extinction: An unnatural history*. New York, NY: Henry Holt & Company.
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*(3), 239–260.
- Nobel Laureates (2001). The next hundred years. Retrieved from <http://www.sciencemag.org/site/feature/data/nobel.xhtml>.
- Leiserowitz, A., Maibach, E., Roser-Renouf, C., Rosenthal, S., & Cutler, M. (2017). *Climate*

- change in the American mind: May 2017*. New Haven, CT: Yale Program on Climate Change Communication.
- Milfont, T. L., & Page, E. (2013). A bibliometric review of the first thirty years of the Journal of Environmental Psychology. *Psychology, 4*(2), 195–216. <https://doi.org/10.1080/21711976.2013.10773866>.
- Molden, D. C., & Dweck, C. S. (2006). Finding "meaning" in psychology: A lay theories approach to self-regulation, social perception, and social development. *American Psychologist, 61*(3), 192–203.
- O' Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis, 19*(3), 461–471.
- Oreskes, N., & Conway, E. M. (2014). *The collapse of western civilization*. New York, NY: Columbia University Press.
- Panno, A., Carrus, G., Maricchiolo, F., & Mannetti, L. (2015). Cognitive reappraisal and pro-environmental behavior: The role of global climate change perception. *European Journal of Social Psychology, 45*(7), 858–867.
- Pearce, W., Grundmann, R., Hulme, M., Raman, S., Hadley Kershaw, E., & Tsovalis, J. (2017). Beyond counting climate consensus. *Environmental Communication, 11*(6), 723–730. <https://doi.org/10.1080/17524032.2017.1333965>.
- Pew Research Center. (2017). *F or Earth Day, here's how Americans view environmental issues*. Retrieved from <https://www.pewresearch.org/fact-tank/2017/04/20/for-earth-day-heres-how-americans-view-environmental-issues/>.
- Pew Research Center. (2019). *U.S. Public views on climate and energy*. Retrieved from <https://www.pewresearch.org/science/2019/11/25/u-s-public-views-on-climate-and-energy/>.
- Pidgeon, N. (2012). Public understanding of, and attitudes to, climate change: UK and international perspectives and policy. *Climate Policy, 12*(sup01), S85–S106.
- Price, J. C., Walker, I. A., & Boschetti, F. (2014). Measuring cultural values and beliefs about environment to identify their role in climate change responses. *Journal of Environmental Psychology, 37*, 8–20. <https://doi.org/10.1016/j.jenvp.2013.10.001>.
- Robins, R. W., & Pals, J. L. (2002). Implicit self-theories in the academic domain: Implications for goal orientation, attributions, affect, and self-esteem change. *Self and Identity, 1*, 313–336.
- Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research, 99*(6), 323–338.
- Schumann, K., & Dweck, C. S. (2014). Who accepts responsibility for their transgressions? *Personality and Social Psychology Bulletin, 40*(12), 1598–1610. <https://doi.org/10.1177/0146167214552789>.
- Sinatra, G. M., Kardash, C. A. M., Taasobshirazi, G., & Lombardi, D. (2012). Promoting attitude change and expressed willingness to take action toward climate change in college students. *Instructional Science, 40*(1), 1–17. <https://doi.org/10.1007/s11251-011-9166-5>.
- Sisk, V. F., Burgoyne, A. P., Sun, J., Butler, J. L., & Macnamara, B. N. (2018). To what extent and under which circumstances are growth mind-sets important to academic achievement? Two meta-analyses. *Psychological Science, 29*(4), 549–571.
- Slovic, P. (2000). Rational actors and rational fools: The influence of affect on judgment and decision-making. *Roger Williams University Law Review, 6*(1), 163–212.
- Soliman, M., & Wilson, A. E. (2017). Seeing change and being change in the world: The relationship between lay theories about the world and environmental intentions. *Journal of Environmental Psychology, 50*, 104–111. <https://doi.org/10.1016/j.jenvp.2017.01.008>.
- Stenling, A., Hassmén, P., & Holmström, S. (2014). Implicit beliefs of ability, approach avoidance goals and cognitive anxiety among team sport athletes. *European Journal of Sport Science, 14*(7), 720–729.
- Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*(3), 407–424. <https://doi.org/10.1111/0022-4537.00175>.
- Stevens, W. K. (2007). *On the global climate beat, doubt gives way to certainty*. New York, Times.
- Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G. S., Reser, J., ... Weber, E. (2009). *Psychology and global climate change: Addressing a multi-faceted phenomenon and set of challenges. A report by the American Psychological Association's task force on the interface between psychology and global climate change*. Washington, DC: American Psychological Association.
- Tempelaar, D. T., Rienties, B., Giesbers, B., & Gijsselaers, W. H. (2015). The pivotal role of effort beliefs in mediating implicit theories of intelligence and achievement goals and academic motivations. *Social Psychology of Education, 18*(1), 101–120.
- Van der Linden, S. L. D., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS One, 10*(2), 2–9. <https://doi.org/10.1371/journal.pone.0118489>.
- Weber, E. U. (2010). What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change, 1*(3), 332–342.
- Wohl, M. J., Cohen-Chen, S., Halperin, E., Caouette, J., Hayes, N., & Hornsey, M. J. (2015). Belief in the malleability of groups strengthens the tenuous link between a collective apology and intergroup forgiveness. *Personality and Social Psychology Bulletin, 41*(5), 714–725.