A climate action intervention to boost individual and collective climate mitigation behaviors in young adults

Anna Castiglione, Cameron Brick, Gianluca Esposito, Andrea Bizzego

**Programmatic PCI Registered Report, Stage 1**

**Abstract**

We present a programmatic research line to test whether a longitudinal intervention aiming to increase key psychological correlates of pro-environmental behavior motivates young adults to take climate action. In five longitudinal studies, we will test and optimize a six-week, in-person intervention, exposing participants to interactive lessons and activities that were developed from existing psychological theories and interventions. The goal is to increase pro-climate behavior by leveraging 12 psychological correlates such as beliefs, attitudes and affect. Before and after the intervention, participants will complete surveys measuring the psychological correlates, and also report individual and collective pro-climate behaviors via Ecological Momentary Assessment (EMA). Each study will include a control group. The psychological correlates and behavior will be measured again after three months to assess the medium-term effectiveness of the intervention. The studies will target young adults at different life stages (high school and university students) and two countries (Italy and the Netherlands). The results and participant feedback from each study will be used to update the intervention for the following studies, within each life stage.The longitudinal design, the intensive manipulations and EMA’s ecological validity are uniquely capable of revealing causal evidence that changes in beliefs, attitudes and affect lead to climate action across age groups and cultures.

*Keywords:* climate change, climate crisis, climate action, climate activism, pro-climate behavior, pro-environmental behavior, climate anxiety, climate education

**Introduction**

It has been known for decades that human-caused greenhouse gas emissions are a profound threat to human thriving, and the solutions are clear. As warned by the Intergovernmental Panel on Climate Change, we need to quickly phase-out the extraction and burning of fossil fuels for energy and transportation, and reduce highly polluting industrial and agricultural practices (IPCC, 2022; Ripple et al., 2019). However, governments and people are acting too slowly, increasing the probability of dangerous tipping points (Ripple et al., 2019). Cutting emissions requires two parallel changes. First, governments must urgently implement emission reduction regulations. Second, individuals must shift behaviors towards personal and collective emission reduction. People’s engagement, especially at the collective level, can achieve meaningful climate mitigation (Tokar, 2020; Rees et al., 2014), for example by pressuring governments to implement urgent climate policies, and pushing communities, companies and institutions to consume fewer high-emission products and services (Fisher & Nasrin, 2021).

Despite the urgency of the climate crisis, few people are currently taking action, especially at the collective level. For example, less than 0,1% engage in grassroots collective climate action (Aron, 2022). Many are simply unaware of the causes and effects of anthropogenic greenhouse gas emissions (Ranney et al., 2016). Others are blocked from turning their awareness into action (Gifford, 2011) due to multiple psychological obstacles. Some examples are A. the perception that global warming is far away in space and in time, and not directly salient to us (McAdam 2017; Weber 2006); B. the social dilemma inherent in the decision to act for the long-term collective versus immediate individual interest (Claessens et al., 2022; Steg et al., 2014); C. the paralyzing fear of a crumbling future (Clayton, 2020); D. the power structures supporting the current extractivist economy seem inaccessible to individual citizens (Schmitt et al., 2020); E. climate change is a widely-distributed problem (spanning from agriculture and biodiversity to socio-political stability) and the solution is global and complex, which reduces people’s sense of personal efficacy (Castiglione et al., 2022).

However, these barriers are sometimes overcome. Environmental psychology has identified psychological correlates of pro-environmental behavior, which may be triggers of individual and collective pro-climate engagement (for individual behaviors see Gaterslebe, 2023 and Lange et al., 2019, for collective behaviors see Bamberg et al., 2018, Bamberg et al., 2015 and Castiglione et al., 2020). Some examples of psychological factors are emotional engagement (e.g. fear or anger; van der Linden 20175; van der Linden 2017; [Sabherwal et al., 2021](https://pdf.sciencedirectassets.com/272402/1-s2.0-S0272494421X00047/1-s2.0-S0272494421000931/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEJX%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJIMEYCIQDMcBZEM1wEZa7SdWVWbXmMcezNkWi8d1BFRDSCqNKxWwIhAI31BcTB2vF1gDo8s6bPAr4WW0NGZfThd9rhaRAZ%2Bns8KrwFCO7%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1IgwQBBFyt4taODmPeoMqkAXQ4XYfaTQrUCl9yqtecw%2BgQy0WxTd%2BnhIz2boAyKm9NGCXQs31CBZIbNQxx%2BTGyH1EicXj3DHUQD7b0hIs0pmsQhTFdCzupbp5kDpbWQtg4RviPcR%2FLnJigyftqMj7tf2Wq9S2hY9IhipBEPmQmx4Rh4at8F8oEa7nt61lvbkaqUpBQ2%2Fp5xhwVeJzREF9w4CSl9O9X7ihPRx005%2B78SRE7T9Ig5bI2wA5xoNmpbPD4wVohfEdrLUEZPCzIeM8GXdJ1AuNV%2BRjYCdSj%2BWZRc0H%2BWmFaLo6AklVsKlP6B1fdZvnUuun%2BcHvXWMtNPGD5g9qG7ATWqnzaOruiwsixiE1OeCdAPyw08Sy4DxineV1vHti1TAcEhNa0u2M2BMjocS6iJBpMC4VmwLfIu1ZmIciyacXFVgk5HAo5LoUF0rctW5bYXg7mzTShEyCX3fGRU%2BPyDGj%2Bs7uSYQTrHdNYEMzxOZhWxYDlyxwQA5MW%2FZi%2BSkWW%2BXBHllj4rzCj3uOUNfCJ4Db6%2BPqRghT6fLJ0AbRKy3CqZmaPJkPWPJvzd1lGpSP17Bx%2FGc3Eo%2B7TRVA884gA4lBn6WssS2Wg5LEo2CJzR2wA%2BFMdIV5ile7cv1cuaID6InBsYS%2BkBJ3ujj2g5oztzDWhob1ztAofmA%2B7qSwuC0FvB9Nnph%2BuBsN%2FLGnVxwMk%2FV9dTNgnNOApZltv7aE41gDNlEhJ3q6tRI2Sd71VuLWG4%2BmBLSEW5RTKfmne9GsdWxlkP4sQLtBrq0MPgeKvDUyzSURze7LtCPn21dRx4LJh8odhQ%2BKkvZ6a8OkuyPwjYKhwoT36zDHcMC3PVlC%2BXylVKPuQOtuw6wFfGsr0SxrbgKY0UO4KNvA87eH2zC6kKKrBjqwATOT9WAXjt3FAAnARjTD2WHDolrXc20XhkacCc1%2BVJ3mcA8l%2B0AaQ43b7Lsbp8LVtuOuboICzmQlQDyTMEhwy0I%2BQeHNHymF2BsLaZTWMmcIjQ1iCnhL%2Fp0QY2YeLgy8wqLJXN%2FwQ9XoboWaNqw4skplxz0S5rsgWjb%2BzUYKFE6OYjszG%2FnqVIpSq4x%2FjI9vjS4HvXfyWe2LO5RNNkerbjoBAXWIHCcF7%2FTdbVm55JP9&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20231130T140642Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY5TGH44NA%2F20231130%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=6703e7defa96bd348934157406110fc58545c0ad2b67111de2d66bb4914d1635&hash=28732de9ca5d4051525859183c92a65ff9b37d578e7e3d26a1984057a32a01ac&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0272494421000931&tid=spdf-bcb59738-36d5-464c-a219-24834093a4fb&sid=11ddc11564b13247116b39e25c3f739ee9d2gxrq)), the perception of self and collective efficacy (Hamann et al., 2023), self and collective environmental identity (Mayer & Frantz 2004; Brick and Lai 2018), social norms (Constantino et al., [2022](https://journals.sagepub.com/doi/full/10.1177/15291006221105279); Fielding et al., 2008) and cognitive alternatives (Wright et al., 2020). Such factors may interact via complex dynamics, and there have been attempts to build theoretical frameworks for how they modulate pro-environmental action. However, as argued by Castiglione et al. (2022), there are systematic problems with these attempts. First, there is often a lack of causal evidence between the psychological factors analyzed and behavior, due to the use of cross-sectional rather than longitudinal designs (e.g., Roser-Renouf et al., 2014; Fielding 2008). Second, there is substantial noise and bias in the commonly adopted self-report measures of pro-environmental behavior; many studies measure recall for distant memories of behavior which is prone to error and bias (e.g. Koller et al., 2023; Berger, 2017; Kormos & Gifford, 2014; Lange et al., 2020; Lange & Dewitte, 2019), or hypothetical future intentions (e.g. Shi et al., 2023; Roser Renouf et al., 2014; Fielding et al., 2008; Ockwell et al., 2009), rather than measuring current behaviors. To understand whether some of these psychological factors are true triggers of pro-climate behavior, we need more longitudinal designs tracking current behavior with ecologically valid tools.

One Registered Report tested whether a 12-week video intervention increased some key psychological predictors of pro-environmental behavior, and, as a result, collective climate action (Castiglione et al., 2022). The intervention boosted affective engagement, collective efficacy, and self-efficacy, but did not significantly increase attendance of activism events (measured by observation, not self-report). Interviews suggested that the online study design undercut the social interaction participants wanted to join events. To test these ideas, a smaller in-person replication was run, but only 2 out of 38 participants engaged in activism (5%). The lack of a significant behavior change may be due to specific limitations of these studies. First, the design lacked the social interaction necessary to engage participants into collective behaviors, even in the in-person iteration. Second, it lacked an action competence component; participants received theoretical information about climate change and collective action, but no practical tools to engage in climate action in their city, university, or neighborhood. Third, the study induced high payment expectations, where multiple participants expected to be paid to attend activist events (on top of the payment received to attend the intervention). Fourth, the behavioral measure used was too rigid, i.e. the few weekly opportunities to join activist events often clashed with the participants’ busy schedule, and they had only one behavioral choice, i.e. joining events entailing social exposure, which may not have fit their personality. Additionally, the intervention failed to boost many of the psychological factors of interest due to our ineffective video-manipulations (which were novel and built amateurly, rather than inspired by existing interventions or theories), possibly dampening the motivation to take action. These and other limitations could have obscured the relationship between the psychological predictors and pro-climate behavior, and prevented behavioral change. A promising way to achieve an effective action-triggering intervention entails a *process,* where the intervention is sequentially tested and optimized for boosting the psychological predictors and behavior.

Young adults (18-35) are especially important to study in the context of climate mitigation because: A. this population has been central to culture change in the past (e.g. raising awareness on civil rights, regime resistance, war opposition and environmental crises) which they could apply to climate mitigation, B. they are about to choose a career path, which they could devolve to climate mitigation, if motivated to take action, C. they can bridge among diverse audiences and age-groups they are connected to (their families, their peers, their school/university environment, leisure communities such as sport, art). However, this population is heterogeneous, due to (among others) different life stages (e.g. whether one is finishing high school or in university) or cultural background (e.g. the country of origin). Elements like life stage and culture likely play an important role in the way young adults react to the climate emergency, e.g., how worried they are, how efficacious they feel, how much they identify with environmentalist groups, and how predisposed they are to take individual or collective action. To understand which psychological factors trigger climate action in young adults, studies should be carried out across young adult sub-groups, differing by life stage and cultural background.

**The current series of studies**

We propose a series of studies to test and optimize a longitudinal intervention aimed to engage young adults from different life stages (highschoolers, university students) and cultures (Italy and the Netherlands) in individual and collective climate action. In each study, participants will take part in six weekly meetings, in which they will learn about climate change topics and acquire practical skills to implement individual and collective climate action where they are. The intervention will leverage 12 psychological correlates of pro-environmental behavior, via validated and ad-hoc manipulations entailing active engagement and interaction by the participants. To test the efficacy of the intervention, we will measure the target psychological correlates and the participants’ individual and collective climate engagement before and after the intervention, and after a follow-up period of three months. Specifically, we will look at two fundamental aspects of behavioral engagement: planning and executing action (Gollwitzer 2006).

Through a sequence of five studies, we will also ensure that the intervention reaches maximum effectiveness, by optimizing it en-route (for high school students and university students, separately) to induce significant behavioral change. Participant feedback via diaries and focus groups will contribute to the optimization of the individual modules and of the intervention as a whole.

**Methods**

For each study, we propose a pre-post design with a control group which in Study 1 (of each life stage) will not undergo the intervention (see the Optimization contingencies and procedures section for studies 2-5). Controlled pre-post longitudinal data can provide robust information about the directional relationship between the psychological factors leveraged by our intervention, and behavior.

**Programmatic format**

We chose a programmatic design to: A. investigate the psychological dynamics underlying climate action across different young adulthood stages (high school and university), in two cultures (Italy and the Netherlands), and B. gradually update and optimize the intervention within each life stage en-route, based on our sequential behavioral and psychological findings. The planned five studies are the following:

University students:

* University students in Italy (study 1)
* University students in Italy (study 2)
* University students in the Netherlands (study 3)

Highschool students:

* High school students in Italy (study 1)
* High school students in Italy (study 2)

Each study will yield one Stage 2 output, with results and discussion and a detailed description of the updates made to the intervention, and the motivations for those updates. In particular, this is an incremental Stage 1 submission; the current submission describes study 1 within each life stage, while the details of the following studies will be developed sequentially, based on the results of the previous Stage 2 output and the current state of the literature. The contingencies by which the intervention protocol will be updated along the way within each life stage are explained in the section “Optimization contingencies and procedure.” The updated Stage 1 protocol will be submitted again for re-evaluation, before studies 2-3 on university students, and before study 2 on high school students. All anonymized data, code, and materials will be shared openly through the Open Science Framework.

**Sample Size**

We ran one power analysis for each main test (Hypotheses 1-3) and selected the most conservative sample size (see Analytic Plan section). To ensure enough power for all our main analyses, we selected the most conservative sample size of N=102. We expect a 30% drop-out for the experimental participants; this includes the dropout expected due to the intensive in-person intervention (30% as suggested by Castiglione et al., 2022) and to the extended behavioral reporting (10% as suggested by [Wrzus et al, 2023](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9999286/); [Richter et al., 2022](https://www.sciencedirect.com/science/article/pii/S2666622722000053); [Nielsen et al., 2021](https://www.sciencedirect.com/science/article/pii/S0272494421000049?casa_token=tgcz6snZVBQAAAAA:PdwaQLOUeM_ESos-psEjJWNIVO31AAOao648FuDL1n7BCGQ97M6VClFENnmpjNlPrRIFPtZCPsE)). For the control participants, we expect a 10% dropout, due to the behavioral reporting alone. All considered, we raised our sample size to N=65 for the experimental group, and N=55 for the control group.

**Outliers**

For both the behavioral and the psychological data we will identify outliers using the boxplot procedure (Sim et al., 2005) with the identify\_outlier function in R. If outliers are found in either psychological or behavioral data, we will apply a 5% robust trimming method, by removing the top and bottom 5% of the data from the respective analysis (Field & Wilcox, 2017).

**Design**

Each study will last 12 weeks, including the intervention (six weeks) and the behavioral tracking periods (two weeks before the intervention, two weeks after the intervention and two weeks after three months).

***Timeline.*** Figure 1 illustrates the sequence of events for each study. First, participants are recruited and assigned to either the experimental or control group. In the first study, the control group will take part in all the study stages, except for the six-week intervention (see the Optimization contingencies and procedures section for changes in the control group for studies 2-5). Then, *baseline* psychological and behavioral measures are collected for all participants: the 12 psychological factors and other psychological variables are measured via online questionnaires, and pro-climate behavior is measured via Ecological Momentary Assessment (EMA), i.e. 14 daily surveys tracking same-day behaviors (weeks 1-2). For the following six weeks the experimental group undergoes the intervention (weeks 3-8). Every week the participants meet in person to complete a module on a specific climate topic, and some module-validation questionnaires, while also continuing to report their daily behaviors via EMA. After the intervention, the *final* psychological and behavioral measures are collected for all participants (questionnaires for the 12 psychological factors, and two-week EMA for behavior; weeks 9-10). Additionally, the experimental group participates in a focus group. The same measures (psychological and behavioral measures) will be collected again 3 months after the intervention (weeks 11-12).

**Figure 1.** Study design.



***A****. participants are recruited,* ***B****. 12 psychological factors and other psychological variables are measured for all participants,* ***C****. for two weeks all participants report their daily behaviors and make an action plan for the following day via EMA,* ***D****. the experimental group undergoes the 6-week intervention,* ***E****. the same 12 psychological factors are measured for all participants,* ***F****. all participants carry out EMA again,* ***G****. the experimental group participates in a focus group,* ***H****. after 3 months, the 12 psychological factors are measured again in all participants, and* ***I****. EMA is carried out again.*

***Recruitment.*** Participants aged 18-35 will be recruited via flyers posted at the location of the specific study (university, school or city), and email announcements (Figure 1A). The experimental group will be recruited to participate in six 3-hour meetings on climate education and fill online questionnaires, while the control group only to complete the questionnaires, due to the difficulty of recruiting all 120 participants for the in-person meetings. However, we will account for potential differences in initial motivation by comparing the mean frequency of reported behaviors in the baseline EMA between the two groups. All participants will be invited to fill a screening questionnaire online via a QR code. Participants who match the inclusion criteria (A. being 18-35 years old, B. being proficient in Italian or English depending on the location of the study, C. believing in climate change, D. not being civically engaged on the climate topic), will be assigned to the control or experimental group, will be informed about the study design and schedule, and will sign an online consent form including their responsibilities over the 12 weeks. Participants will be automatically subscribed to a raffle system, where they will be rewarded for accumulating points during the study (experimental and control participants will be rewarded proportionally to their workload; see Appendix B). Participants in the experimental group that successfully complete all the intervention stages, will also obtain a certificate of participation issued by the University of Trento (e.g. as Open Badge, a digital certification of acquired skills/competences that is recognized internationally).

***Baseline - Psychological measures.*** All participants will receive an online questionnaire, measuring: 1) 12 psychological factors (Emotional engagement, Self-efficacy, Collective efficacy, Theory of change, Cognitive Alternatives, Perceived behavioral control, Implementation Intentions, Social norm, Self-Identity, Collective Identity, Appraisal, Faith in institutions), 2) climate anxiety, 3) behavioral recall, 4) personality traits, and 5) demographics (Figure 1B). See Appendix A for the full measures.

*The 12 Psychological Factors.* For each factor, participants will rate multiple items, adapted from environmental psychology studies (some language was modified, and some items were added to address psychological dynamics and behaviors related to climate change specifically; see Appendix 1 for the full questionnaire and references). Definitions and example items are provided for each psychological factor in Table 1.

*Climate anxiety.* This 20-item questionnaire from Clayton 2020 (see Appendix A) will be used to assess whether engaging in climate mitigation behaviors via the intervention reduces climate anxiety (Clayton, 2020; Doherty, 2015; Bradley et al., 2014).

*Behavioral recall.* This will be the self-reported frequency with which participants performed the individual and collective climate behaviors tracked in the EMA behavioral tracking phase, over the previous three months (see Appendix A).

*Personality questionnaire.* This 5-item questionnaire from Woods et al., 2005, measures the big five personality traits (McCrae & Costa 1987; Extraversion, Agreeableness, Emotional Stability, Conscientiousness, Openness), via five single-item questions using bipolar response scales.

*Demographics questionnaire.* Participants will report their age, gender, education, income, ethnicity and political affiliation.

**Table 1**. *the 12 psychological factors extracted from the Environmental Psychology literature, their definitions and example items used in this study.*

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| **Factor** | **Definition** | **Example item**  |
| *Affective engagement* | Feeling deeply emotionally aroused by the climate crisis, experiencing emotions such as fear, concern, personal risk, and moral outrage (Barkan, 2004; Roser-Renouf et al., 2014; Weber, 2006; Rees et al., 2015).  | “When thinking about the climate crisis, I feel: Fear, guilt, sadness, shame...", from 1 (none at all) to 10 (very strongly)(Rees et al., 2015) |
| *Self-efficacy* | Believing in one's ability to reach an important goal (Barkan, 2004). An individual's proficiency and comfort in executing a particular task (i.e. writing a petition, speaking in public, using social media) (Gulliver et al., 2022). The conviction that one's efforts will significantly further the group's objectives (Bamberg et al., 2018). | “To which extent do you feel capable of supporting a climate initiative/campaign/petition by signing it off or donating to the cause?” from 1(not at all) to 10 (very much)(Gulliver et al., 2022) |
| *Collective efficacy*  | The belief that one’s group can enact a desired change, either directly or indirectly (Bandura, 2000; Jugert et al., 2016; Roser-Renouf et al., 2014; Hamann et al., 2020). The sensation of accomplishment in the group's attainment of goals and in consolidating collective power. Believing in the effectiveness of a group’s proposed solutions to the climate crisis, aligning with the group's prognostic framework, such as reformist, individual, or systemic actions. (Wahlström et al., 2013).  | “Our pro-climate actions as students will encourage others to do the same." from 1 (strongly disagree) to 10 (strongly agree)(Hamann et al., 2020) |
| *Theory of change*  | The extent to which individuals believe that successful climate mitigation actions can start (and progress) from the bottom (i.e. from the grassroots) and spreading to the top (e.g. government)(Castiglione, 2020; Mihaylov & Perkins, 2015; Castiglione et al., 2022). | “Climate mitigation can start locally (e.g. in my city, in my school, in my company) and spread globally", from 1 (completely agree) to 7 (completely disagree) (modified from Castiglione et al., 2022) |
| *Perceived behavioral control* | The control someone feels over whether or not they engage in a specific behavior (Ajzen 1991). How easily someone feels they can engage in pro-climate behaviors (e.g. decreasing one’s CO2 footprint or joining activist events), versus perceiving high instrumental barriers to engagement (i.e. lack of time, money, resources to engage)(Fielding et al., 2008). | “How much control do you have over whether you reduce your personal emissions (from diet, transport, energy and finances)? from 1 (very little control) to 10 (a great deal of control)(modified from Fielding et al., 2008) |
| *Implementation Intentions* | The ability to plan the practical execution of one’s intentions to act. This entails outlining practical action steps through an "if, then" plan. For instance, planning larger-scale actions like organizing a protest on a specific day, or smaller-scale actions like attending a particular climate event at a designated time on a specific day (Gollwitzer et al., 2006). | “I have plans on when, where and how I will engage civically to vote, sign petitions or support campaigns in favor of a climate issue,” from 1 (completely agree) to 7 (completely disagree)(modified from Gollwitzer et al., 2006) |
| *Social norm* | How an individual perceives the opinions of valued others regarding their pro-environmental conduct (Sparkman et al., 2017; Sparkman et al., 2021; Constantino et al., 2022). Feeling inclined (or discouraged) to engage in actions based on the support (or disapproval) received from friends, peers, or family (Fielding 2008). | “Most people who are important to me (friends, family, peers) would approve if I engaged collectively to mitigate climate change (educating others, supporting civic initiatives, doing advocacy or activism), from 1 (completely agree) to 7 (completely disagree)(modified from Fielding et al., 2008) |
| *Environmentalist self*-*identity*  | The degree of connection a person experiences with the broader natural environment and their sense of interconnectedness with nature (Mayer & Frantz 2004). How strongly an individual identifies as an environmentalist and embraces this identity with positivity (Brick et al., 2017; Plant & Devine 1998). | “Engaging collectively with other citizens to mitigate the climate crisis is important to my self-concept," from 1 (completely agree) to 7 (completely disagree)(modified from Plant & Devine 1998).  |
| *Environmentalist collective identity* | Experiencing a strong bond with one's community of activists (Tajfel 1978; Wallis and Loy, 2021; Brick and Lai 2018; Fritsche et al., 2018; Masson et al., 2021; Schulte 2020). Feeling a kinship with the group, due to shared objectives or demographic similarities such as ethnicity, socioeconomic status, age, beliefs, gender identity, LGBTQIA+ affiliation, or political stance. Nurturing close social connections within the organization (Han, 2020). | “I feel strong ties with other environmentalists," from 1 (completely agree) to 7 (completely disagree)(Brick and Lai 2018).  |
| *Faith in institutions* | The perception that political institutions keep public opinion and individual citizens' efforts into account in the decision and policy making process (Saikkonen 2022) and that citizens can have a say in these processes (Miller & Miller 1980). | “People like me don't have any say about what the government does on climate change,” from 1 (completely agree) to 7 (completely disagree)(Miller & Miller 1980)  |
| *Appraisal* | The that a problem exists (e.g. that climate change exists, that it is caused by humans, and that it is dangerous for us) before deciding to address this problem (Wallis and Loy, 2021; Nordlund et al., 2003). | “It is a serious problem that increasing global temperatures are leading to more catastrophic extreme weather events,” from 1 (completely agree) to 7 (completely disagree)(Nordlund et al., 2003) |
| *Cognitive alternatives* | The ability to imagine cognitive alternatives to the environmental status quo, i.e. how easily people can imagine what that sustainable world would be/look like (Wright et al., 2020). | “It is easy to imagine a world where we no longer use fossil fuels”, from 1 (completely Disagree) to 10 (completely Agree) (Wright et al., 2020) |

***Baseline - Ecological Momentary Assessment.*** Participants will fill out one 10-minute daily survey on their phone, reporting their behaviors during the same day, for two weeks. They will first watch an online video describing the behaviors they need to report on, and the EMA procedure. We will measure two behavior types: collective (behaviors typically performed with other people, and having a collective impact), and individual (behaviors performed alone, with an impact typically limited to that one action). For each behavior type, we grouped all the relevant climate mitigation behaviors into four categories. Collective behaviors include: 1) civic participation (i.e. participating in existing civic initiatives regarding climate mitigation), 2) advocacy (formally negotiating with institutions for emission reduction policy), 3) activism (organizing grassroots pressure on institutions for emission reduction policy), 4) education (educating others about climate mitigation). Individual behaviors include reducing one’s carbon footprint from: 1) food consumption, 2) transportation, 3) energy use and 4) finances (e.g. which products and services they buy). Each behavioral category is listed in Table 2, with some examples.

In the video, participants will be informed that, every evening they will receive a survey link on their phone, asking them to: 1. report pro-climate behaviors performed today (action section) and 2. plan pro-climate behaviors for tomorrow (plan section). We want to track planning as a fundamental precursor of behavior, which we hope to strengthen via the intervention (Gollwitzer, 2006). In the plan section, participants can list up to five mitigation behaviors per category that they plan to do the day after. They can also leave any of the categories blank. They will write each behavior in one sentence, under the respective category (for example, under activism they may write “I will contact a local climate organization to start working with them;” under food consumption they may write “I will not eat meat;” under energy conservation they may write “I will reduce heating/cooling in my house”). In the action section, they will be asked whether they performed the actions planned the day before; they will see the same one-sentence behaviors they wrote in the plan section of the previous day, and they will check “yes” if they did it or “no” if they did not. There will be an option to add any unplanned pro-climate behaviors they performed (Figure 1C).

One weakness of EMA is that it uses self reports that may be affected by a social desirability bias (Koller et al., 2023); however, in our design, the comparison with the control group should cancel this effect (especially for the studies employing an active control group, see Optimization contingencies and procedures section).  Additionally, when people are asked to report their behaviors on a daily basis, it is more difficult to lie. On the other hand, EMA is a flexible measure of behavior, contrary to fully objective measures (e.g. in-person attendance to activist events, as in Castiglione et al., 2022); i.e. participants can perform any pro-climate behavior (individual or collective) that best fits their schedule, life routines, and personality. The ecological validity and high-frequency measurements of EMA overcome the biases of other, more common proxies of behavior, such as future intentions and recall of distant behaviors (Lange et al., 2019; Kormos et al., 2014).

**Table 2.** *Behavior types, categories and examples.*

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| **Behavior type** | **Behavior category** | **Examples** |
| Collective | Civic participation | Participating in existing civic initiatives such as signing a petition, donating to a climate campaign, and joining a climate march |
| Advocacy | Negotiating formally with politicians and administrators to introduce and apply climate mitigation policy, via affirmed organizations, formal events such as conferences, or professional settings, lobbying |
| Activism | Organizing grassroots initiatives such as campaigns, petitions, marches, protests and flash mobs, to put pressure on politicians and administrators to introduce and apply climate mitigation policy |
| Education | Organizing or participating in the organization of climate education events/campaigns/programs, or informing others of climate contents via social media  |
| Individual | Food consumption | Cutting meat and dairy products from one’s diet, or only eating local products |
| Transportation | Opting for clean transports such as bike, scooter, electric transports, public transports, walking, and carpooling rather than driving internal combustion cars or flying |
| Energy conservation | Limiting appliance use to the strictly necessary, reducing heating/cooling and hot water use, unplugging appliances, switching lights off |
| Finances | Buying only necessary goods, opting for low carbon services such as home utilities from 100% renewable sources and banking/insurance services with banks/insurances not tied to the fossil fuel industry |

***Intervention.*** The experimental group will undergo a six-week intervention, which is designed to increase pro-climate behavior by boosting 12 psychological correlates (Figure 1D). The participants will attend six three-hour meetings, in a room of the institution where the study is held. Each meeting addresses one module, regarding a specific aspect of the climate crisis and climate action. In each module, we aim to boost two to four psychological factors, via educational content and group activities. An overview of the module topics, description and example activities with reference to the existing literature can be found in Appendix B. Before each meeting, the participants will receive a preparatory “homework” email, with some text/video/podcast introducing the content of the module. Then, on the day of the meeting, the participants will listen to a presentation by a tutor, laying out the core topic of the module. For the rest of the time, they will undergo individual and group activities, such as sharing circles on beliefs, emotions, behaviors and experiences related to the climate crisis, discussions of video contents, small research projects on climate topics, laboratories on personal and institutional decarbonization (see Appendix B for a full description of the activities). At the end of the meeting, they will respond to a few comprehension questions to verify they were paying attention during the module, and will complete a module-validation questionnaire and diary, which we will use to optimize the module content. For the same validation purpose, participants will continue filling the EMA questionnaire during the intervention weeks (see Optimization contingencies and procedures section).

*Topics of the 6 modules*. The core topics of the six modules are: 1) *Intro to the Climate Crisis and Climate Action*, addressing the causes and impacts of the climate crisis, and the psychological obstacles/incentives to mitigation behaviors; 2) *Decarbonization*, on the main greenhouse gasses, their anthropogenic sources, and how to cut them; 3) *Climate Economics*, on switching form a linear extractivist economy to a circular economy; 4) *Systemic Change,* on how societal change can spread from the local to the global; 5) *Civic engagement for the climate I*, on how to create effective bottom-up change, and 6) *Civic engagement for the climate II,* on effective team-work for climate action.

*Factor-boosting activities.* These activities are inspired by existing psychological interventions/theories, and are designed to boost the 12 psychological factors of interest. Some activities replicate existing manipulations that were shown to successfully raise the factor of interest, and/or behavior by leveraging that factor (e.g. [Sabherwal et al., 2021](https://pdf.sciencedirectassets.com/272402/1-s2.0-S0272494421X00047/1-s2.0-S0272494421000931/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEJX%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJIMEYCIQDMcBZEM1wEZa7SdWVWbXmMcezNkWi8d1BFRDSCqNKxWwIhAI31BcTB2vF1gDo8s6bPAr4WW0NGZfThd9rhaRAZ%2Bns8KrwFCO7%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1IgwQBBFyt4taODmPeoMqkAXQ4XYfaTQrUCl9yqtecw%2BgQy0WxTd%2BnhIz2boAyKm9NGCXQs31CBZIbNQxx%2BTGyH1EicXj3DHUQD7b0hIs0pmsQhTFdCzupbp5kDpbWQtg4RviPcR%2FLnJigyftqMj7tf2Wq9S2hY9IhipBEPmQmx4Rh4at8F8oEa7nt61lvbkaqUpBQ2%2Fp5xhwVeJzREF9w4CSl9O9X7ihPRx005%2B78SRE7T9Ig5bI2wA5xoNmpbPD4wVohfEdrLUEZPCzIeM8GXdJ1AuNV%2BRjYCdSj%2BWZRc0H%2BWmFaLo6AklVsKlP6B1fdZvnUuun%2BcHvXWMtNPGD5g9qG7ATWqnzaOruiwsixiE1OeCdAPyw08Sy4DxineV1vHti1TAcEhNa0u2M2BMjocS6iJBpMC4VmwLfIu1ZmIciyacXFVgk5HAo5LoUF0rctW5bYXg7mzTShEyCX3fGRU%2BPyDGj%2Bs7uSYQTrHdNYEMzxOZhWxYDlyxwQA5MW%2FZi%2BSkWW%2BXBHllj4rzCj3uOUNfCJ4Db6%2BPqRghT6fLJ0AbRKy3CqZmaPJkPWPJvzd1lGpSP17Bx%2FGc3Eo%2B7TRVA884gA4lBn6WssS2Wg5LEo2CJzR2wA%2BFMdIV5ile7cv1cuaID6InBsYS%2BkBJ3ujj2g5oztzDWhob1ztAofmA%2B7qSwuC0FvB9Nnph%2BuBsN%2FLGnVxwMk%2FV9dTNgnNOApZltv7aE41gDNlEhJ3q6tRI2Sd71VuLWG4%2BmBLSEW5RTKfmne9GsdWxlkP4sQLtBrq0MPgeKvDUyzSURze7LtCPn21dRx4LJh8odhQ%2BKkvZ6a8OkuyPwjYKhwoT36zDHcMC3PVlC%2BXylVKPuQOtuw6wFfGsr0SxrbgKY0UO4KNvA87eH2zC6kKKrBjqwATOT9WAXjt3FAAnARjTD2WHDolrXc20XhkacCc1%2BVJ3mcA8l%2B0AaQ43b7Lsbp8LVtuOuboICzmQlQDyTMEhwy0I%2BQeHNHymF2BsLaZTWMmcIjQ1iCnhL%2Fp0QY2YeLgy8wqLJXN%2FwQ9XoboWaNqw4skplxz0S5rsgWjb%2BzUYKFE6OYjszG%2FnqVIpSq4x%2FjI9vjS4HvXfyWe2LO5RNNkerbjoBAXWIHCcF7%2FTdbVm55JP9&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20231130T140642Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY5TGH44NA%2F20231130%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=6703e7defa96bd348934157406110fc58545c0ad2b67111de2d66bb4914d1635&hash=28732de9ca5d4051525859183c92a65ff9b37d578e7e3d26a1984057a32a01ac&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0272494421000931&tid=spdf-bcb59738-36d5-464c-a219-24834093a4fb&sid=11ddc11564b13247116b39e25c3f739ee9d2gxrq) for emotional engagement; Sparkman et al., 2020 for social norms; Jans, 2021 for collective identity; [Bieniek-Tobasco et al., 2020](https://journals.sagepub.com/doi/10.1177/1075547020951794) for self-efficacy; Schmitt et al., 2023 for cognitive alternatives; Feldman et al., 2015 for faith in institutions). Other activities we created ex-novo, and were either inspired by existing theories (e.g. van der Linden 2017 for emotional engagement; Hamann et al., 2023 and Gulliver et al., 2022 for self-efficacy; Lacerenza et al., 2018 for collective identity) or from the authors’ personal experiences in climate advocacy. Each activity will aim to manipulate one factor, and they will be distributed across the six modules coherently with the core topic of the module. See Supplementary Table 1 for a full list of the activities in the intervention modules; these will be subject to changes during the optimization process (see Optimization contingencies and procedures section).

***Final - Psychological measures.*** At the end of the intervention all participants will complete a final survey, similar to the baseline survey, including the 12 psychological factors and climate anxiety (but not personality, demographics and behavioral recall questions) (Figure 1E).

***Final - Ecological Momentary Assessment.*** All participants will undergo two weeks of EMA behavioral tracking, as in the baseline stage (Figure 1F).

***Final - Focus Group.*** The participants from the experimental group will be invited to a final focus group session held online, during which they will share their experiences in the intervention (Figure 1G). Aided by their module diaries, they will give us a comprehensive feedback on which elements of the intervention (modules, activities, contents, setup, tutor attitudes) they found motivating or activating, and which elements they found boring or disempowering. They will also report on which behavioral categories they found easier to engage in, and which more difficult, and why. Finally, we will ask them what they would change about the intervention to boost its efficacy.

***Follow-Up - Psychological measures and Ecological Momentary Assessment.*** Three months after the end of the study, all participants will fill out the same psychological questionnaire online, including the 12 psychological factors, climate anxiety and behavioral recall (Figure 1H).

They will also undergo two more weeks of EMA behavioral tracking (Figure 1I).

**Exclusion Criteria**

Participants will be excluded for the following reasons: A. they complete fewer than nine daily surveys out of 14 (i.e. they miss more than five surveys), in any of the baseline or final EMA behavioral tracking stages, B. they fail to fill any one of the baseline or final psychological questionnaires, C. they fail to attend more than two out of six intervention meetings.

**Hypotheses**

***H1: Pre-post behavioral engagement.*** Individual and collective behavioral engagement will increase due to the intervention. Specifically: A. tracked behavior via EMA will increase from baseline to final, and from baseline to follow-up, B. recalled behavior will increase from baseline to follow-up, and C. planning and plan implementation will increase from baseline to final and from baseline to follow-up.

***H2: Pre-post psychological factors.*** Someof the 12 psychological factors will increase from baseline to final.

***H3: Behavioral change as a result of psychological change.*** If any change in individual and/or collective behavioral engagement occurs from baseline to final or from baseline to follow-up, it will be explained by the change in the 12 psychological factors increasing from baseline to final.

***H4: Intervention improvement over time.*** The programmatic optimization process will make the intervention more effective at triggering individual and collective pro-climate behaviors within each life stage (high school and university students), over the iterations.

**Analytic Plan**

*Behavioral scores*. Two coders will go through the one-sentence open responses in the EMA surveys. Answers that do not describe relevant individual or collective pro-climate behaviors will be excluded, based on a coding list of relevant pro-climate behaviors, which we have compiled from multiple sources (see Appendix A). Behaviors that are relevant but listed in the wrong behavior type (individual vs collective) or category (energy, transport, food, finances, education, civic support, advocacy, activism) will be recorded in the correct behavior type/category. For both individual and collective behaviors, each participant will be assigned three scores for each day of the three EMA periods (baseline, final and follow-up): an Action Score, a Plan Score and a Percentage Score. The *Action Score* will be the absolute number of relevant actions participants performed that day, across all eight categories (e.g. 3 actions performed). This will include actions that were not planned the day before. The *Plan Score* will be the number of relevant actions they had planned the day before, to be executed that day (e.g. 5 actions planned). If participants open the daily survey but do not report any planned or performed actions, their Action and Plan scores will be 0. If participants do not open the survey, we will assign “NA” to both scores. The *Percentage Score* will be the percentage of the planned actions that were actually performed (e.g. 3/5, 60%). For behavioral recall (the self-reported frequency of individual and collective climate behaviors over the previous three months, measured in the baseline and follow-up questionnaires), we will calculate the mean score of the 1-10 ratings for individual and collective behaviors, resulting in one composite score per behavior type.

*Psychological predictors.* For each of the 12 psychological factors, we will calculate the mean score of the 1-10 ratings across that factor's items, resulting in one composite score per factor. However, because some of the factor questionnaires have been considerably modified from prior studies (“Theory of Change”, “Collective Efficacy”, “Collective Identity”, “Appraisal”), we will run a reliability analysis for those factors. If the composite score within each time point for that factor has a Cronbach’s alpha < .7, questions will be removed until the alpha is above this threshold. If there is no such solution, a single face-valid item will be chosen prior to hypothesis testing.

**Analyses**

***Pre-post behavioral engagement (H1).***

**H1a**. For each behavior type (individual versus collective) we will compare the participants’ Action Scores tracked via EMA during the baseline, final and follow-up tracking period, between the experimental and control groups. First, to consider the breadth of the multi-day data (14 Action Scores per time point), we will run a linear mixed effect model, preserving the 14 repeated measures; this model will include as predictors Time (Baseline, Final), Condition (Experimental, Control), and the Time\*Condition interaction, and Participant as random factor. To test the significance of the Time\*Condition interaction, we will use sequential ANOVA decomposition of fixed effects, comparing the main model to a model including all the same predictors except for the Time\*Condition interaction. Second, we will take the mean of the repeated measures of the Action Scores for each time point (baseline, final and follow-up), and run a repeated measure ANOVA, with factors Time (within: Baseline, Final, Follow-up) x Condition (between: Experimental, Control).

**H1b.** For behavioral recall, entailing only one composite score per time point (baseline and follow-up), we will run a simple analysis of variance (ANOVA), with factors Time (Baseline, Follow-up) x Condition (Experimental, Control)*.*

**H1c.** We will repeat the analyses from H1a to predict the Plan Score (i.e. the number of planned activities recorded for each day of the behavioral tracking) and the Percentage Score (i.e. the percentage of activities planned that were actually implemented), from baseline to final and from baseline to follow-up. This is to assess whether the intervention significantly improved the participants’ plan-making, and their ability to stick to their plans.

***Pre-post psychological factors (H2)****.*

For each psychological factor, we will compare the composite score from the baseline, to the final, to the follow-up questionnaires. We will run a between-within repeated measure analysis of variance (ANOVA), with factors Time (Baseline, Final, Follow-up) x Condition (Experimental, Control). The factors with a significant Time\*Condition interaction indicating an increase from baseline to final will be included in the next analytical phase (H3). The comparison between baseline and follow-up will only be used for post-hoc investigations (see Outcome and Implications section).

***Behavioral change as a result of psychological change (*H3*)****.*

***H3a.***For each behavior type (individual and collective), we will test whether the change in the psychological factors predicts the final mean Action Score. We will run a multiple linear regression model of the mean final Action Score, with predictors: A. the mean baseline Action Score, B. the baseline score for each psychological factor, and C. the change (from baseline to final) in each psychological factor. Note that only the change in the factors with a significant Time\*Condition interaction from the H2 analysis will be included. Because this hypothesis is not strictly related to the effectiveness of our intervention (as for H1 and H2), but rather to the general relationship between the psychological factors and behavior, in this analysis we will not include condition as a predictor. We will run the same model to predict the mean follow-up Action Score, for each behavior type.

**H3b.** We will run the same model to predict the mean follow-up score of recalled behavior, with predictors: A. the mean baseline recalled behavior score, B. the baseline score for each psychological factor, and C. the change (from baseline to final) in each psychological factor.

**H3c.** We will repeat the same linear regression model for each action type, to predict the mean final and follow-up Plan Score and Percentage Score, with predictors: A. the mean baseline Plan Score/Percentage Score, B. the baseline score for each psychological factor, and C. the change (from baseline to final) in each psychological factor.

***Intervention improvement over time (H4).***

**H4a.** For each life stage, and for each behavior type, we will assess the improvement in the behavioral engagement (both action and planning) induced by our intervention, over the iterations. We will run a regression model of the mean final Action Score for all the studies, with predictors: A. the mean baseline Action Score, B. Condition, C. Study ID, and D. the interaction Condition\*Study ID. Study ID indicates the temporal order in which each study was conducted (1=first study, 2=second study…), within each life stage. We expect that the Condition\*Study ID interaction will be significant, i.e. that the later the iteration, the greater the difference will be between the two conditions’ final Action Score (after accounting for the mean baseline Action Score of each). The same analytical procedure will be used to compare the participants’ Action Score from the baseline to the follow-up behavioral tracking periods.

**H4b.** We will repeat the same analyses to predict the mean final and the mean follow-up recalled behavior.

**H4c.** We will repeat the same analyses to predict the mean final and the mean follow-up Plan Score and Percentage Score.

**Power analysis**

In the Hypothesis 1 analysis we will test whether behavior changes from before to after the intervention for the experimental versus the control groups, via a linear mixed effects model; we used PANGEA (v0.2) to perform a power sensitivity analysis (2\*3 mixed, within\*between method), with effect size *d* = 0.25, power = 0.85, replicates = 14. The effect size was based on a recent meta analysis on behavioral interventions that promote climate action (either by goal-setting or commitment to climate change mitigation), which found effect sizes ranging from *d* = 0.25-0.27 (Nisa et al., 2019). This power analysis yielded *N* = 100 (50 participants per condition).

In the Hypothesis 2 analysis, we will test whether each psychological factor increases from before to after the intervention, across conditions, via repeated measure within-between ANOVAs. We used the R function *wp.rmanova* from the *WebPower* package with *f* = 0.3 (*d* = 0.60), alpha = 0.05, power = 0.85, and ε = 1. We chose *f* = 0.3 as the smallest effect size of interest (Lakens, 2022) for a manipulation-induced psychological change that is likely to lead to a behavioral change. Similar effect sizes were found in manipulation studies inducing a change in one of the psychological factors tested here (e.g. Masson et al., 2014; Jugert et al., 2016; [Jachimowicz et al., 2018](https://www.nature.com/articles/s41562-018-0434-0); [Bieniek-Tobasco](https://journals.sagepub.com/doi/10.1177/1075547020951794%22%20%5Cl%20%22con1) et al., 2020; Feldman et al., 2015; Ramstetter et al., 2022; [Sabherwal et al., 2021](https://pdf.sciencedirectassets.com/272402/1-s2.0-S0272494421X00047/1-s2.0-S0272494421000931/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEJX%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJIMEYCIQDMcBZEM1wEZa7SdWVWbXmMcezNkWi8d1BFRDSCqNKxWwIhAI31BcTB2vF1gDo8s6bPAr4WW0NGZfThd9rhaRAZ%2Bns8KrwFCO7%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1IgwQBBFyt4taODmPeoMqkAXQ4XYfaTQrUCl9yqtecw%2BgQy0WxTd%2BnhIz2boAyKm9NGCXQs31CBZIbNQxx%2BTGyH1EicXj3DHUQD7b0hIs0pmsQhTFdCzupbp5kDpbWQtg4RviPcR%2FLnJigyftqMj7tf2Wq9S2hY9IhipBEPmQmx4Rh4at8F8oEa7nt61lvbkaqUpBQ2%2Fp5xhwVeJzREF9w4CSl9O9X7ihPRx005%2B78SRE7T9Ig5bI2wA5xoNmpbPD4wVohfEdrLUEZPCzIeM8GXdJ1AuNV%2BRjYCdSj%2BWZRc0H%2BWmFaLo6AklVsKlP6B1fdZvnUuun%2BcHvXWMtNPGD5g9qG7ATWqnzaOruiwsixiE1OeCdAPyw08Sy4DxineV1vHti1TAcEhNa0u2M2BMjocS6iJBpMC4VmwLfIu1ZmIciyacXFVgk5HAo5LoUF0rctW5bYXg7mzTShEyCX3fGRU%2BPyDGj%2Bs7uSYQTrHdNYEMzxOZhWxYDlyxwQA5MW%2FZi%2BSkWW%2BXBHllj4rzCj3uOUNfCJ4Db6%2BPqRghT6fLJ0AbRKy3CqZmaPJkPWPJvzd1lGpSP17Bx%2FGc3Eo%2B7TRVA884gA4lBn6WssS2Wg5LEo2CJzR2wA%2BFMdIV5ile7cv1cuaID6InBsYS%2BkBJ3ujj2g5oztzDWhob1ztAofmA%2B7qSwuC0FvB9Nnph%2BuBsN%2FLGnVxwMk%2FV9dTNgnNOApZltv7aE41gDNlEhJ3q6tRI2Sd71VuLWG4%2BmBLSEW5RTKfmne9GsdWxlkP4sQLtBrq0MPgeKvDUyzSURze7LtCPn21dRx4LJh8odhQ%2BKkvZ6a8OkuyPwjYKhwoT36zDHcMC3PVlC%2BXylVKPuQOtuw6wFfGsr0SxrbgKY0UO4KNvA87eH2zC6kKKrBjqwATOT9WAXjt3FAAnARjTD2WHDolrXc20XhkacCc1%2BVJ3mcA8l%2B0AaQ43b7Lsbp8LVtuOuboICzmQlQDyTMEhwy0I%2BQeHNHymF2BsLaZTWMmcIjQ1iCnhL%2Fp0QY2YeLgy8wqLJXN%2FwQ9XoboWaNqw4skplxz0S5rsgWjb%2BzUYKFE6OYjszG%2FnqVIpSq4x%2FjI9vjS4HvXfyWe2LO5RNNkerbjoBAXWIHCcF7%2FTdbVm55JP9&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20231130T140642Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY5TGH44NA%2F20231130%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=6703e7defa96bd348934157406110fc58545c0ad2b67111de2d66bb4914d1635&hash=28732de9ca5d4051525859183c92a65ff9b37d578e7e3d26a1984057a32a01ac&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0272494421000931&tid=spdf-bcb59738-36d5-464c-a219-24834093a4fb&sid=11ddc11564b13247116b39e25c3f739ee9d2gxrq); Castiglione et al., 2022). This power analysis yielded a total *N* = 102 (51 participants per condition).

In the Hypothesis 3 analysis, we test whether any change in behavior is predicted by a change in any of the target psychological factors via a multiple linear regression model; we used R package *pwr*, with $f^{2}$= 0.15 (*d* = 0.78), alpha = 0.05, power = 0.85 and numerator *df* =5 (assuming only some of the psychological factors will enter this analytical phase). We chose *f*^2 = 0.15 aggregating across the literature correlating the 12 psychological factors and pro-environmental behavior (e.g. Brick and Lai 2018; Hamman et al., 2020; [Jachimowicz et al., 2018](https://www.nature.com/articles/s41562-018-0434-0); Jans 2021; Wright et al., 2020; Gulliver et al., 2022; Lalot et al., 2019). This power analysis yielded a total *N* = 102 (51 participants per condition).

**Optimization contingencies and procedures**

From one study to the next, some key elements of the intervention will be updated. In particular, the elements that will be subject to change are: 1. the modules’ contents and activities, 2. the psychological factors targeted and the related questionnaires, 3. the module themes, 4. the module order and format, 5. the tutoring approach, 5. the reward system and 6. the control group type. These elements will be updated based on: the main results, the module validation measures, the focus group, and the upcoming psychological literature (see “Optimization procedures”).

***Module validation measures.***

*Module-specific questionnaires.* After every module, participants will fill-out a module-specific questionnaire, measuring the psychological factors targeted by that module (the questions will be identical to those used in the baseline questionnaire to measure that factor). For each module X and for each targeted factor, we will run a t-test comparing the factor score at baseline (or at the latest module targeting that factor) against the factor score after module X. This will provide information on whether module X successfully raised each targeted factor, which we will use for the optimization process.

*Module diary.* At the end of each module, participants will write a short diary, with the instruction to report on (one sentence per point): 1) what they learned that day , 2) which elements of the module (especially the activities, the contents, the meeting format and the tutor approach) they found positive (motivating, encouraging, empowering), 3) which they found negative (boring, demotivating, disempowering), 4) how they can use what they learned to increase (reduce) their positive (negative) individual and collective climate impact, and 5) whether last week’s module triggered a behavioral change in them, and if so, which element of that module did so.

*Intervention Ecological Momentary Assessment.* We will continue measuring ecological momentary assessment in both conditions during the intervention, via the same daily 10-minute questionnaire, as in the baseline period. For each module, we will calculate an mean behavioral score for the six days prior and the six days following (separately for individual and collective behaviors). As part of the optimization process, we will then run a t-test comparing behavior before and after the module, to assess whether any module triggered a particularly big behavioral change.

***Optimization procedures.*** The expected potential changes are:

* **module contents and activities**. In particular, for each module we will A. expand the contents and activities that effectively boosted behavior, and B. revisit the contents (from the presentations and homework) and the activities that did not boost the psychological factors.
1. Expand effective presentations and activities. We will find the modules effectively increasing behavior (individual or collective) from the six days prior to the six days following (as measured by the intervention EMA). We will identify the specific triggering contents and activities that likely led to this change, based on:
	1. which module-specific factors (targeted by the factor-specific activities in the module) successfully increased
	2. the participant feedback on what contents/activities they found engaging/empowering, as reported in their module diaries, and in the focus group

 We will consider expanding the effective contents and activities to other

modules or within that same module.

1. Revisit ineffective contents and activities. For all modules (even those that effectively increase behavior), we will revisit all contents/activities that failed to boost the module-specific targeted factors, or that were demotivating to the participants. We will identify the ineffective contents/activities based on:
	1. which module-specific factors (targeted by the factor-specific activities in the module) did not increase
	2. the participant feedback on what contents/activities they found boring/disempowering, as reported in their module diaries, and in the focus group

We will consider modifying the ineffective contents/activities by integrating the participants’ suggestions, and/or substituting them with new manipulations shown by the most recent literature to effectively increase the targeted factors.

* **Psychological factors targeted** **and questionnaires**. After each iteration, we will run a small literature search, on the psychological factors involved in pro-climate behavior:
	1. If additional psychological factors emerge as strong correlates of pro-climate behavior, we will add activities/contents targeting those factors in the module that fits best, and the related psychological items in the questionnaires.
	2. If we find studies validating questionnaires for our current factors that we think are better suited than the current questionnaires, we will substitute the items for those factors.
* **module themes.** We will assess whether the module themes constitute an effective framework for the factor-boosting activities, based on the module diaries and focus group feedback. We will consider changing some of the themes.
* **module order and** **format**. We will assess the effectiveness of the order of the modules, the amount of time spent on presentations and on group activities and the learning/interactive tools used, based on the module diaries and focus group feedback. We will consider tweaking some of these elements.
* **tutoring approach.** We will assess how engaging and inspiring the tutoring approach was for the participants based on the module diaries and focus group. We will consider adapting the tutoring approach to this feedback.
* **reward system.** We will adjust the reward system based on the impact it has on the accountability and drop-out rate of the participants, according to the focus group.
* **control group type.** In the first study within each life stage we will use a passive control group (completing the pre-post measurements, but not attending the intervention). This is because in the first iteration of this very novel intervention we expect low-probability of confirming our hypotheses (based on e.g. Castiglione et al., 2022). In fact, a passive control group is a low-severity test of whether *any* effect is induced in the experimental group; yet, it enables us to rule out external triggers (e.g. an extreme event occurring in the region, or a climate-related political event inducing psychological or behavioral effects in the participants). Nevertheless, if the outcomes of Study 1 revealed a significant difference between the experimental and control groups for H1, H2 and H3, in the following studies we will switch to an active control group (i.e. going through a mock in-person intervention), to rule out internal triggers unrelated to our 12 psychological correlates (e.g. social interaction, gathering in a room of the university, reward amount, time invested in this study, and others).

What will *not* change in the study iterations is: the intervention design and format (longitudinal design with a control group, multiple in-person meetings consisting of learning content delivered by a tutor, and group activities aimed at raising the psychological factors), the measuring time points (baseline, final, follow-up), the dependent variables (individual and collective pro-climate behavior), the psychological and behavioral measure media (questionnaires for the psychological factors and EMA for behavior), the module-validation measures (diary, module-specific questionnaires).

**Outcomes and implications**

There is an urgent need for people to reduce their greenhouse gas emissions, and to pressure their local administrations to implement emission reduction policies. Despite a large body of literature studying the psychological correlates of pro-environmental action, there is little semi-causal/directional evidence that such correlates can motivate people to take sustained individual and collective climate action, across life stages and cultures. Building upon Castiglione et al., 2022, this series of studies aims at testing a novel intervention, manipulating 12 psychological correlates to boost individual and collective pro-climate behavior. This will be done across five different audiences, differing by life stage and culture. In Table 3 we divide the possible outcomes of each study into four main scenarios, with the related implications. We expect that our cross-age investigation will unveil a multi-faceted picture of the psychological underpinnings of pro-climate behavior in young adults; i.e. the intervention may change different psychological factors or increase different behavior types, or reveal different psychological factors as predictors of behavior in high school and university students. Different reactions may emerge across Italian and Dutch university students as well; this would highlight the importance of cross-cultural differences that could be later studied in high school students as well, and used to optimize the intervention further. Overall, the results from this series of studies will add to a comprehensive theoretical understanding of pro-climate behavior in young adults, via a sound methodological approach.

**Table 3.** *Possible outcomes for each study, referred to the three main hypotheses H1, H2, H3, and their implications*

|  |  |  |
| --- | --- | --- |
| **H1 scenario** | **H2 and H3 outcomes** | **Implications** |
| **H1 scenario 1:****Individual and/or collective behavioral engagement (planning and/or doing) increases from baseline to final *and* from baseline to follow up for experimental > control.**  | Scenario 1.1:H2: some of the 12 psychological factors increase from baseline to final, for experimental > control H3: the boosted psychological factors predict the increase in individual and/or collective behavioral engagement from baseline to final and from baseline to follow-up | The theoretical implications are that: A) we will have demonstrated a directional (semi-casual) relationship between the increasing factors and climate action, B) our methodology could be used to test complex theories of collective climate action, by adding or taking out any of the psychological factors, or combining them differently in the modules. The applied implication is that the increasing factors should be incorporated and leveraged in climate communication / education programs, to boost behavioral engagement in the audience. |
| Scenario 1.2:H2: some of the 12 psychological factors increase from baseline to final, for experimental > controlH3: no psychological factor significantly predicts behavior.  | We cannot conclude that there is a directional relationship between the boosted psychological factors and climate action. Something else induced the behavioral change observed in H1 (this can be investigated via post-hoc evaluation of the module diaries and the focus group). |
| Scenario 1.3:H2: none of the 12 psychological factors increases from baseline to final, for experimental > control | Same as scenario 1.2. |
| **H1 scenario 2:****Individual and/or collective behavioral engagement (planning and/or doing) increases from *baseline to final* for experimental > control, but not from baseline to follow-up.** | Scenario 2.1:H2: some of the 12 psychological factors increase from baseline to final, for experimental > controlH3: the boosted psychological factors predict the behavioral increase in individual and/or collective pro-climate behaviors from baseline to final. | This confirms a directional relationship between the increasing factors and *short–term* climate action. Same implications as for scenario 1.1, although only related to short-term behaviors. Post-hoc investigations can be carried out as to why the increase in the psychological factors did not lead to a long-term behavioral change (e.g. look at whether the 12 psychological factors have declined from final to follow-up). |
| Scenario 2.2:H2: some of the 12 psychological factors increase from baseline to final, for experimental > controlH3: no psychological factors predict the behavioral increase in individual and/or collective pro-climate behaviors from baseline to final.  | We cannot conclude that there is a directional relationship between the increasing psychological factors and *short-term* climate action. Something else in the intervention induced the short-term behavioral change (explore via module diaries and focus group). |
| Scenario 2.3:H2: none of the 12 psychological factors increases from baseline to final, for experimental > control | Same as scenario 2.2. |
| **H1 scenario 3:****Individual and/or collective behavioral engagement (planning and/or doing) increases from *baseline to follow-up* for experimental > control, but not from baseline to final.**  | Scenario 3.1:H2: some of the 12 psychological factors increase from baseline to final, for experimental > control H3: the boosted psychological factors predict the behavioral increase in individual and/or collective pro-climate behaviors from baseline to follow-up.  | This confirms a directional relationship between the boosted psychological factors and *long–term* climate action. Same implications as for scenario 1.1, but only for long-term behavior. Post-hoc analyses may look into what leads to the lag of behavioral activation (e.g. maybe the psychological factors increased from final to follow-up due to the long-term congnitive processing of the intervention contents, or to an external event).  |
| Scenario 3.2:H2: some of the 12 psychological factors increase from baseline to final, for experimental > controlH3: no psychological factors predict the behavioral increase in individual and/or collective pro-climate behaviors from baseline to follow-up. | We cannot conclude that there is a directional relationship between the increasing psychological factors and *long-term* climate action. Something else in the intervention (or in the period between the final and the follow-up stages) induced the long-term behavioral change (explore via module diaries and focus group). |
| Scenario 3.3:H2: none of the 12 psychological factors increases from baseline to final, for experimental > control | Same as scenario 3.2 |
| **H1 scenario 4:****Individual and/or collective behavioral engagement (planning and/or doing) does not increase for the experimental versus control groups.** | Scenario 4.1:H2**:** some of the 12 psychological factors increase from baseline to final, for experimental > control | We cannot conclude that there is a directional relationship between the increasing psychological factors and climate action. Lack of behavioral activation may be due to the failure to increase some of the psychological factors. Post-hoc analysis should look into which factors were not boosted, and update the intervention contents/activities targeting those factors. |
| Scenario 4.2:H2*:* none of the 12 psychological factors increases from baseline to final, for experimental > control | The contents and activities used in the intervention were ineffective both in triggering real-world climate action and boosting the target psychological factors. Revisit the intervention contents based on the validation metrics.  |

Regardless of the outcome scenario of each study, the main results and validation measures collected throughout the intervention will help us optimize the intervention efficacy en-route, for both high school and university students. At its most effective shape, the intervention should successfully increase individual/collective pro-climate behavior, and at least some of the psychological factors, unveiling the directional/semi-causal relationship between the two. If successful, our method may be extended to other European and extra-European student audiences and other age-groups, to develop an increasingly rich understanding of what drives people around the world to engage in climate mitigation.

**Summary: study design template**

 Table 4 summarizes the research questions, hypotheses, sampling and analysis plans, and prospective interpretation of confirmatory/disconfirmatory outcomes of each individual study.

**Table 4.** *Summary table*

|  |  |  |  |
| --- | --- | --- | --- |
| **Question** | Can a 6-week educational intervention leveraging 12 psychological correlates of pro-environmental behavior increase short- and/or long-term engagement in individual and collective climate action?  | Can a 6-week educational intervention boost 12 psychological correlates of pro-environmental behavior? | Does the increase in the 12 psychological correlates of pro-environmental behaviour predict engagement in individual and collective climate action?  |
| **Hypothesis** | H1. Individual and collective behavioral engagement will increase due to the intervention. Specifically: A. tracked behavior via EMA will increase from baseline to final, and from baseline to follow-up, B. recalled behavior will increase from baseline to follow-up, and C. planning and plan implementation will increase from baseline to final and from baseline to follow-up.  | H2. Some or all of the 12 psychological factors will increase from baseline to final. | H3. If any change in individual and/or collective behavioral engagement occurs from baseline to final (baseline to follow-up), it will be explained by the change in at least some of the 12 psychological factors from baseline to final. |
| **Sampling Plan** | PANGEA (v0.2) was used to perform a power sensitivity analysis, for the 2\*3 mixed (within\*between) methods design, with effect size d = 0.25, power = 0.85, replicates=14. This power analysis yielded a total N = 100 (50 participants per condition) | We used the R function wp.rmanova from the *WebPower* package to perform a power analysis with alpha = 0.05, power = 0.85, effect size f(V) = 0.3, and ε=1. Also this power analysis yielded a total N = 102 (with 51 participants per condition). | We used R package pwr to perform a power analysis with f^2=0.15, alpha=0.05, power=0.85 and numerator d.f.=5 (assuming only some of the psychological factors will enter this analytical phase). This power analysis yielded a total N = 102 (51 participants per condition). |
| **Analysis Plan** | Linear mixed effect model, with Time (Baseline, Final, Follow-up), Condition (Experimental, Control) and Time\*Condition interaction as predictors, and Participant as random factor. We will run sequential ANOVA for significance. | We will run a between-within repeated measure analysis of variance (ANOVA), with factors Time (Baseline, Final, Follow-up) x Condition (Experimental, Control). | We will run a multiple linear regression model of the mean final behavioral score, with predictors: A. the mean baseline Action Score, B. the baseline score for each psychological factor, and C. the change (form baseline to final) in each psychological factor. Only the change in the factors with a significant Time\*Condition interaction (from H2) will be included. We will run the same model looking at the change in behavior from baseline to follow-up, for each behavior type. |
| **Rationale for deciding the sensitivity of the test** | We chose d=0.25 as effect size of interest, according to a recent meta-analysis on behavioral interventions that promote climate action (either by goal-setting or commitment to climate change mitigation), which found effect sizes ranging from d = 0.253 to d = 0.266 (Nisa et al., 2019) | We chose f(V)=0.3 as the minimum effect size of interest (Lakens, 2022) for a manipulation-induced psychological change that is likely to lead to a behavioral change; similar effect sizes were found in multiple manipulation studies inducing a change in one of the psychological factors tested here, that led to a behavioral change (e.g. Masson et al., 2014; Jugert et al., 2016; Bieniek-Tobasco et al., 2020; Feldman et al., 2015; Ramstetter et al., 2022; Sabherwal et al., 2021). | We chose f^2=0.15 aggregating across the literature finding correlations between the 12 psychological factors and pro-environmental behavior (e.g. Brick and Lai 2018; Hamman et al., 2020; Jachimowicz et al., 2018; Jans2021 with F^2=0.03; Wright et al., 2020; Gulliver et al., 2022; Lalot et al., 2019). |
| **Interpretation given different outcomes** | **Confirm:** for the individual and/or collective behavior type, we will find a significant Time\*Condition interaction, where the experimental participants show a greater increase in behavioral engagement than the control participants from baseline to final and/or from baseline to follow-up (within subject effect), regardless of the between-subject effects.  **Disconfirm:** we will not find a time\*condition interaction for neither individual nor collective pro-climate behavior, or we will find an interaction in the opposite direction (i.e. greater increase in behavior for the control group, or a decrease for the experimental group). | **Confirm:** for at least one of the psychological factors, we will find a significant Time\*Condition interaction where the experimental group shows a greater increase from baseline to final compared to the control group (within subject effect), regardless of the between-subject effects.  **Disconfirm:** we will find no Time\*Condition interaction for any of the psychological factors, or we will find an interaction in the opposite direction (i.e. greater increase in the factors for the control group or a decrease for the experimental group).  | **Confirm:** for the individual and/or collective behavior type, we will find that the change from baseline to final in one or more of the psychological factors significantly predicts the final and/or follow-up behavioral score, taking into account the baseline behavioral score.  **Disconfirm:** No psychological factor change will significantly predict the change in individual/collective behavior, neither from baseline to final nor from baseline to follow-up.  |
| **Confirmatory outcome conditions** | For each behavioral outcome: A diagram of a different scale  Description automatically generated with medium confidence | For each psychological factor:A diagram of a psychological and psychological score  Description automatically generated with medium confidence |  |
| **Disconfirmatory outcome conditions** | For each behavioral outcome:A diagram of a graph  Description automatically generated with medium confidence | For each psychological factor:A diagram of a different level of control  Description automatically generated with medium confidence |  |
| **Theory that could be shown wrong by the outcomes** |  |  | The 12 psychological correlates tested are directional/causal triggers of real-world individual and or collective pro-climate behaviors |

**Note on participant self-selection**

This study will require a considerable effort from the participants (attending six in-person 3-hour meetings, responding to daily behavioral tracking for multiple weeks, and filling three psychological questionnaires). While we will provide an official certificate of attendance and prizes for the most diligent participants, the reward is likely not going to balance the effort. This will likely lead to highly-motivated participants joining the study, who may be already prone to take climate action (but are not active yet, as per our screening procedure). We argue that, while this self-selection prevents full generalizability of the results (e.g. to those who are not yet highly motivated), it has multiple benefits: 1) highly motivated participants are more likely to stay until the end of the study, reducing the drop-out rate, 2) they are more likely to fulfill the intervention tasks, leading to more complete measurements, and 3) triggering highly motivated people to practically engage in pro-climate behavior is still a high-impact objective; as shown by multiple large surveys (e.g. Howe et al., 2015 and Flynn et al., 2021), the majority of people world-wide are already worried about climate change, and motivated to do something to address the problem (but most are inactive, likely due to psychological barriers such as the abstraction and complexity of this crisis and its solutions). Therefore, our alarmed and motivated audience may provide results that are still generalizable to a relevant share of the population.

The highly motivated participants joining and completing the study may start off with high pro-environmental values and a pro-environmental lifestyle, posing the risk for a ceiling effect. However, even among those caring for the environment, it is often misunderstood what pro-environmental behaviors are specifically emission reduction behaviors, which are the focus of our study series (e.g. [Kause et al., 2019](https://iopscience.iop.org/article/10.1088/1748-9326/ab465d)). Most participants attracted to this study may already engage in low-effort pro-environmental behaviors (such as recycling, low water consumption, etcetera), but not necessarily in more sophisticated pro-climate behaviors (i.e. all those behaviors aimed at reducing greenhouse gas emissions). Therefore, we do not expect a high frequency of emission reduction behaviors such as those specified in our coding list, even among those caring about the environment. Additionally, one of our inclusion criteria is to not be civically engaged for the climate; therefore,  at least for the collective behavioral categories, there is extensive room to improve (note that 50% of the intervention content aims to increase collective engagement). For the above reasons we do not expect a critical ceiling effect.

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**Appendix A**

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**SCREENING SURVEY**

*Beliefs about Climate Change:*

1. Regardless of its cause, I am certain that climate change is actually occurring. Yes, No
2. Human activities are a significant cause of climate change. Yes, No

*Additional selection criteria:*

1. Are you between 18 and 15 years of age? Yes, No
2. Are you proficient in Italian? Yes, No
3. Have you ever participated in an activist event held by a climate organization (a protest, a community-organizing event, a sit-in or anything similar), and if so, how many times? Never, Once, A few times (less than 10), I do it often

**BASELINE SURVEY**

***12 psychological factors***

1. Emotional engagement (modified from Howe et al., 2015, Leiserowitz et al., 2006; Rees et al., 2015; Landmann et al., 2023)
	1. How worried are you about greenhouse gas emissions in general? From 1(not at all) to 10 (very much)
	2. How much do you think greenhouse gas emissions will harm plants and animal species:
		1. Globally ? From 1 (not at all) to 10 (very much)
		2. In your region? From 1 (not at all) to 10 (very much)
	3. How much do you think greenhouse gas emissions will harm future generations:
		1. Globally ? From 1 (not at all) to 10 (very much)
		2. In your region? From 1 (not at all) to 10 (very much)
	4. How much do you think greenhouse gas emissions will harm:
		1. People globally?
		2. People in developing countries? From 1 (not at all) to 10 (very much)
		3. You? From 1 (not at all) to 10 (very much)
	5. When do you think greenhouse gas emissions will begin to harm:
		1. People around the world? [reversed] 1 (It is already happening), 2 (in the next 10 years), 3 (in the next 100 years), 4 (in the next 100 years), 5 (in more than 100 years)
		2. People in your region? [reversed] 1 (It is already happening), 2 (in the next 10 years), 3 (in the next 100 years), 4 (in the next 100 years), 5 (in more than 100 years)
		3. You personally? (It is already happening), 2 (in the next 5 years), 3 (in the next 10 years), 4 (in the next 20 years), 5 (in more than 20 years)
	6. Many people’s standard of living will decrease due to greenhouse gas emissions:
		1. Worldwide 1 (Not at all likely) to 10 (Highly likely)
		2. In your region 1 (Not at all likely) to 10 (Highly likely)
	7. There will be an increase in extreme weather events in the world due to greenhouse gas emissions. 1 (Not at all likely) to 10 (Highly likely)
	8. Rate how much risk there is that greenhouse gas emissions will reduce your personal well-being in the following ways, from 1 (No risk) to 10 (High risk):
		1. By increasing extreme weather events in your area
		2. By politically destabilizing your region
		3. Causing job loss in your region
		4. Forcing you to migrate
		5. Reducing the resources available in your region (such as water, food, services, etc.)
	9. When thinking about the climate crisis, I feel: From 1 (not at all) to 10 (very much):
		1. Guit
		2. Sadness
		3. Fear
		4. Shame
		5. Anger
		6. Emotional coldness
		7. Empathy for those affected by climate impacts
		8. Hope
		9. Connection with the people working on mitigation
2. Self-efficacy (modified from Hamann et al., 2020; Gulliver et al., 2022)
3. Changes in my daily routines (from diet, energy use, transports and finances) can contribute to mitigate climate change. From 1 (Completely Disagree) to 10 (Completely Agree)
4. I don’t think that I as an individual can encourage others to [reversed]: From 1 (Completely Disagree) to 10 (Completely Agree)
	1. Reduce their personal emissions (from diet, energy, transports and finances)
	2. Engage in collective pro-climate behaviors (such as civic participation, climate education, advocacy and activism)
5. My individual pro-climate actions will encourage others to do the same. From 1(not at all) to 10 (very much)
6. My collective pro-climate actions will encourage others to do the same. From 1(not at all) to 10 (very much)
7. I think that my skills and competences can help a climate group/organization be successful. From 1(not at all) to 10 (very much)
8. To which extent do you feel capable of: From 1(not at all) to 10 (very much)
	1. Distributing information about a climate group/organization’s cause
	2. Organizing a local event with a climate group/organization
	3. Doing volunteer tasks for a climate group/organization outside of meetings
	4. Volunteering in the role of a committee member, coordinator or similar for a climate group/organization
	5. Giving a presentation or talk on a climate issue
	6. Recruiting new volunteers for a climate group/organization
	7. Starting a new environmental project, campaign, program or group/organization
	8. Confronting public representatives about a climate issue
	9. Organizing a protest/demonstration with a climate group/organization
9. Collective efficacy (modified from Hamann et al., 2020; Gulliver et al., 2022)
10. I think that our joint actions as students can contribute to mitigating the climate crisis, by reducing greenhouse gas emissions. From 1 (not at all) to 10 (very much)
11. I don’t think that we as students can encourage others to promote emission-reduction behaviors. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
12. Our pro-climate actions as students will encourage others to do the same. From 1 (not at all) to 10 (very much)
13. Together people who volunteer in a climate group/organization can achieve relevant emission reduction goals. From 1 (Completely Disagree) to 10 (Completely Agree)
14. Efforts to volunteer for the climate in a group/organization in my city are a waste of time. From 1 (Completely Disagree) to 10 (Completely Agree)
15. A group of climate advocates/activists can convince a local administration to enact climate policy. From 1 (not at all) to 10 (very much)
16. A climate group/organization can use effective strategies (identify clear goals and targets, use effective tactics, plan timelines) to achieve emission reduction goals. From 1 (not at all) to 10 (very much)
17. Regardless of the strategy they use, climate groups/organizations are unlikely to reach relevant mitigation goals. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
18. A solid internal structure (distribution of roles, responsibilities and leadership) can make a climate group/organization particularly effective at achieving emission reduction goals. From 1 (not at all) to 10 (very much)
19. Regardless of their internal structure, climate groups/organizations are unlikely to reach relevant mitigation goals. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
20. Theory of change - from local to global (modified from Castiglione et al., 2022)

 From 1 (Completely Disagree) to 10 (Completely Agree):

1. Climate mitigation can start locally (e.g. in my city, in my school, in my company) and spread globally.
2. Reducing emissions at one place (e.g. in my city, in my school, in my company) creates a precedent for similar places to do the same.
3. If a group of people puts pressure on a local administration to cut emissions, and another group does the same in another place, little by little we can create global change.
4. Reducing emissions in one place (e.g. in my city, in my school, in my company) is completely useless because big polluters somewhere else are countering this effort. [reversed]
5. Climate mitigation can start with common people asking/putting pressure on their local administrations to cut emissions.
6. Climate mitigation can only start with governments enacting emission reduction policies from the top. [reversed]
7. Voting is the only way that a person like me can have any say about climate policy. [reversed]
8. Cognitive alternatives (Wright et al., 2020)

From 1 (Completely Disagree) to 10 (Completely Agree):

1. I can easily imagine a world in which we supply all of our energy needs without harming the natural world.
2. It is easy to imagine a world where we no longer use fossil fuels.
3. I can clearly imagine a world where we exclusively use agricultural practices that protect the natural habitats of animals.
4. I can imagine a world where politicians care more about minimizing the population's negative impact on the environment than economic growth.
5. I can think of numerous methods of achieving a world where carbon emissions are reduced below current levels.
6. I can easily imagine a world where people see themselves as integrated with nature, rather than masters over the natural world.
7. When I imagine what an ecologically sustainable existence for humans would be like, I can picture it in detail.
8. A harmonious relationship between humans and the natural world is easy for me to imagine.
9. I can easily imagine a city/neighborhood/company that cut all financial ties with the fossil fuel industry.
10. I can easily imagine a fully decarbonized city/neighborhood/company.
11. Perceived behavioral control (modified from Fielding et al, 2008)
12. How much control do you have over whether you:
	1. Reduce your personal emissions (from diet, transports, energy and finances)? From 1(not at all) to 10 (very much)
	2. Engage in collective climate action (such as civic participation, education, advocacy, activism)? From 1(not at all) to 10 (very much)"
13. How difficult would it be for you to:
	1. Reduce your personal emissions (from diet, transports, energy and finances)? [reversed] From 1(not at all difficult) to 10 (very difficult)
	2. Engage in collective climate action (such as civic participation, education, advocacy, activism)? From 1(not at all difficult) to 10 (very difficult)
14. It is mostly up to me whether I:
	1. Reduce my personal emissions (from diet, transports, energy and finances). From 1 (Completely Disagree) to 10 (Completely Agree)
	2. Engage in collective climate action (such as civic participation, education, advocacy, activism)? From 1 (Completely Disagree) to 10 (Completely Agree)
15. Implementation Intentions (modified from Gollwitzer 2006)
16. I have plans for when, where and how I will: From 1 (I have no plan) to 10 (I have a detailed plan)
	1. reduce my energy carbon footprint
	2. reduce my transportation carbon footprint
	3. reduce my transportation carbon footprint
	4. reduce my finance carbon footprint
	5. engage civically to vote, sign petitions or support campaigns in favor of a climate issue
	6. educate others on pro-climate behaviors they can engage with
	7. engage in climate advocacy
	8. engage in climate activism
17. Social norm (modified from Fielding 2008)

From 1 (Completely Disagree) to 10 (Completely Agree)

1. Young adults like me are already reducing their personal emissions (from diet, energy, transportation, and finances).
2. Young adults like me are already engaging collectively to mitigate climate change (engaging civically, educating others, doing advocacy or activism).

From 1 (Completely DIsapprove) to 10 (Completely Approve)

1. Most people who are important to me (friends, family, peers) would approve/disapprove if I reduced my personal emissions (from diet, energy, transportation, shopping).
2. Most people who are important to me (friends, family, peers) would approve if I engaged collectively to mitigate climate change (engaging civically, educating others, doing advocacy or activism).
3. Self-Identity (modified from Plant & Devine, 1998; Mayer & Frantz 2004)
4. I attempt to engage in collective pro-climate behaviors (such as civic participation, climate education, advocacy and activism) because it is personally important to me. From 1 (Completely Disagree) to 10 (Completely Agree)
5. I attempt to engage in individual pro-climate behaviors (reducing my emissions from diet, energy use, transportation and shopping) people because it is personally important to me. From 1 (Completely Disagree) to 10 (Completely Agree)
6. According to my personal values, living a high-carbon lifestyle is OK. [inverted] From 1 (Completely Disagree) to 10 (Completely Agree)
7. According to my personal values, NOT engaging with other citizens to mitigate the climate crisis is OK. [inverted] From 1 (Completely Disagree) to 10 (Completely Agree)
8. Living a low-carbon lifestyle is important to my self-concept. From 1(not at all) to 10 (very much)
9. Engaging collectively with other citizens to mitigate the climate crisis is important to my self-concept. From 1(not at all) to 10 (very much)
10. I think of the natural world as a community to which I belong. From 1(not at all) to 10 (very much)
11. I often feel disconnected from nature. [reversed] From 1(not at all) to 10 (very much)
12. When I think of my life, I imagine myself to be part of a larger cyclical process of living. From 1 (Completely Disagree) to 10 (Completely Agree)
13. I often feel a kinship with animals and plants. From 1(not at all) to 10 (very much)
14. I have a deep understanding of how my actions affect the natural world. From 1 (Completely Disagree) to 10 (Completely Agree)
15. I feel that all inhabitants of Earth, human, and nonhuman, share a common ‘life force’. From 1(not at all) to 10 (very much)
16. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
17. My personal welfare is independent of the welfare of the natural world. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
18. Collective Identity (modified from Brick and Lai 2018)
19. I see myself as an environmentalist. From 1 (Completely Disagree) to 10 (Completely Agree)
20. I feel strong ties with environmentalists. From 1 (Completely Disagree) to 10 (Completely Agree)
21. I identify with other environmentalists. From 1 (not at all) to 10 (very much)
22. I see myself as part of a community of people, reducing their personal greenhouse gas emissions to mitigate climate change. From 1 (not at all) to 10 (very much)
23. I see myself as part of a community of civically active people, who are participating in collective climate mitigation initiatives (such as climate advocacy, climate activism and climate education). From 1 (not at all) to 10 (very much)
24. Appraisal (modified from [Nordlund et al., 2003](https://www.sciencedirect.com/science/article/pii/S0272494403000379))
25. I am aware of the sources, impacts and solutions of climate change. From 1 (Completely Disagree) to 10 (Completely Agree)
26. A small increase in global temperatures leads to more catastrophic extreme weather events. From 1 (not at all) to 10 (very much)
27. It is a serious problem that increasing global temperatures are leading to more catastrophic extreme weather events. From 1 (Completely Disagree) to 10 (Completely Agree)
28. The the increasing global temperature is threatening our way of living as we know it today. From 1 (not at all) to 10 (very much)
29. We need to urgently decarbonize our society, in order to mitigate climate change. From 1 (not at all) to 10 (very much)
30. Some core financial, economic, political, and social mechanisms in our society are preventing true emission reductions. From 1 (not at all) to 10 (very much)
31. Faith in institutions (modified from Saikkonen et al., 2022; Miller & Miller 1980)
32. Elected representatives quickly forget the worries of ordinary citizens on climate change. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
33. Citizens’ opinions on climate change are considered in political decision-making. From 1 (Completely Disagree) to 10 (Completely Agree)
34. Politicians do not care about the opinions of ordinary people regarding climate change. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
35. I believe that some politicians want to enact true emission reduction policy. From 1(not at all) to 10 (very much)
36. Politicians don't care about climate change nor want to do anything to mitigate it. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)
37. I believe that politicians will enact climate mitigation policy, if asked to do so by the people. From 1 (Completely Disagree) to 10 (Completely Agree)
38. People like me don't have any say about what the government does on climate change. From 1 (Completely Disagree) to 10 (Completely Agree)
39. Sometimes politics and government seem so complicated that a person like me can't really do anything to influence climate policy. [reversed] From 1 (Completely Disagree) to 10 (Completely Agree)

***Climate Anxiety:***

Modified from Climate anxiety scale (Clayton 2020). All items: From 1 (Completely Disagree) to 10 (Completely Agree)

1. Thinking about climate change makes it difficult for me to concentrate.
2. Thinking about climate change makes it difficult for me to sleep.
3. I have nightmares about climate change
4. I find myself crying because of climate change
5. I think, “why can't I handle climate change better?”
6. I write down my thoughts about climate change and analyze them
7. I think, “why do I react to climate change this way?”
8. My concerns about climate change make it hard for me to have fun with my
family or friends.
9. My concerns about climate change interfere with my ability to get work or
school assignments done.
10. My concerns about climate change undermine my ability to work to my
potential.
11. My friends say I think about climate change too much.
12. I have been directly affected by climate change
13. I know someone who has been directly affected by climate change
14. I have noticed a change in a place that is important to me due to climate
change
15. I wish I behaved more sustainably
16. I try to reduce my behaviors that contribute to climate change
17. I feel guilty if I waste energy
18. I believe I can do something to help address the problem of climate change

***Behavioral recall***

In the past 3 months, how often did you do the following?

Rate: 1) Never, 2) about once a month, 3) about once a week, 4) about twice a week, 5) every day:

1. Reduce your diet carbon footprint (e.g. by limiting meat or dairy consumption or only eating local products)?
2. Reduce your transportation carbon footprint (e.g. by limiting car use or plane travel and favoring biking, public transports or walking)?
3. Reduce your energy use carbon footprint (e.g. by unplugging appliances, switching lights off, limiting hot water use)?
4. Reduce your finances carbon footprint (reducing the amount of non-essential goods you buy, or avoiding investing your money in fossil-related products and services)?
5. Engage civically to vote, sign petitions, support campaigns in favor of a climate issue or join a demonstration?
6. Educate others on the causes and impact of the climate crisis, and pro-climate behaviors they can do to mitigate it?
7. Engage in climate advocacy by contacting and negotiating with local administrations/institutions to enact emission reduction policies?
8. Engage in climate activism by organizing grassroots events to put pressure on local administrations/institutions to enact emission reduction policies?

***Personality questionnaire***

From Woods et al., 2005. For each of the 5 personality traits, there will be a cursor to move toward one of the two extremes (separated by “/”), within a 10-point scale.

Circle the point on each scale to indicate how much you think each description sounds like you:

1. Someone who is talkative, outgoing, is comfortable around people, but could be noisy and attention seeking / someone who is a reserved, private person, doesn't like to draw attention to themselves and can be shy around strangers (EXTRAVERSION)
2. Someone who is forthright, tends to be critical and find fault with others and doesn't suffer fools gladly / someone who is generally trusting and forgiving, is interested in people, but can be taken for granted and finds it difficult to say no (AGREEABLENESS)
3. Someone who is sensitive and excitable, and can be tense / someone who is relaxed, unemotional, rarely gets irritated and seldom feels blue (EMOTIONAL STABILITY)
4. Someone who likes to plan things, likes to tidy up, pays attention to details, but can be rigid or inflexible / someone who doesn't necessarily work to a schedule, tends to be flexible, but disorganized and often forgets to put things back in their proper place (CONSCIENTIOUSNESS)
5. Someone who is a practical person who is not interested in abstract ideas, prefers work that is routine and has few artistic interests / someone who spends time reflecting on things, has an active imagination and likes to think up new ways of doing things, but may lack pragmatism (OPENNESS)

***Demographics***

1. How old are you?
2. Gender: Male, Female, Other (specify), Prefer not to say
3. What is your education level? Highschool diploma, Bachelor degree, Master’s degree doctorate degree
4. What is your income? Less than 10,000, 10,000-20,000, 20,000-30,000, 40,000-50,000, 50,000-60,00….140,000-150,000, 150,000 or more.
5. What is your political orientation? Right, Left, Center
6. In which country were you born?
7. In which country did you primarily grow up?

**ECOLOGICAL MOMENTARY ASSESSMENT AND CODING**

Every evening for two weeks, participants will fill out a 10-minute survey, composed of two parts: 1) actions performed today and 2) action plan for tomorrow. Under individual and collective behaviors, they will have to report/plan on up to 5 behaviors, for each of 4 behavioral categories. The behavioral categories for individual behaviors are: 1. energy conservation, 2. food consumption, 3. transportation, 4. finances. The behavioral categories for collective behaviors are: 1. climate education, 2. civic support, 3. advocacy, 4. activism. Before the beginning of the study, the participants will watch an instructional video, explaining the 8 behavioral categories in detail (with examples), and how to complete the survey; this video will be linked at the beginning of every survey.

***Part 1: Actions performed today***

INDIVIDUAL BEHAVIORS

1. Energy
	1. Did you \_\_\_\_\_\_ today? Yes, No

*[where \_\_\_\_\_ is the action they had planned the day before, to conserve energy]*

* 1. … *[there will be up to 5 questions like i., depending on how many behaviors were planned the day before for this category]*
1. Food
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …
2. Transportation
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …
3. Finances
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …

COLLECTIVE BEHAVIORS

1. Education
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …
2. Civic support
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …
3. Advocacy
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …
4. Activism
	1. Did you \_\_\_\_\_\_ today? Yes, No
	2. …

***Part 2: Action plan for tomorrow***

INDIVIDUAL BEHAVIORS

1. Energy:

What are you going to do tomorrow to conserve energy? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Food:

What are you going to do tomorrow to reduce your diet carbon footprint? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Transportation:

What are you going to do tomorrow to reduce your transportation carbon footprint? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Finances:

What are you going to do tomorrow to reduce your finances' carbon footprint? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

COLLECTIVE BEHAVIORS

1. Education:

What are you going to do tomorrow to educate people around you about climate mitigation? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Civic support:

What are you going to do tomorrow to participate in civic initiatives for the climate? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Advocacy:

What are you going to do tomorrow to engage in climate advocacy? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

1. Activism:

What are you going to do tomorrow to engage in climate activism? Describe up to 5 behaviors (write one sentence per behavior):

 1.\_\_\_\_\_\_\_\_\_2.\_\_\_\_\_\_\_\_\_3.\_\_\_\_\_\_\_\_\_4.\_\_\_\_\_\_\_\_\_5.\_\_\_\_\_\_\_\_\_

The behaviors listed by the participants will be screened using the following coding list of relevant emission reduction behaviors, for each behavioral category considered (individual: transportation, energy consumption, diet, consumerism, and collective: education, civic engagement, advocacy, activism). This list was compiled from multiple sources (see below). Specifically, we selected emission-reduction behaviors that are commensurate with a daily report such as EMA (e.g. decisions such as not having children may be too big and long-term to fit a daily behavioral report), and that take into account our student audience (e.g. students may not have decisional power to weatherizing their home, as most rent out their homes). Any behavior reported by the participants fitting a behavior description in the following list will be included. All other behaviors will be excluded, unless relevant for emission reduction, according to our sources and judgment; in this case, we will update the coding list by including a description of the novel relevant behavior.

|  |  |  |
| --- | --- | --- |
| **Behavior type** | **Behavioral category** | **Relevant behaviors** |
| *Collective* | Civic Participation | * Donate to a climate cause (e.g., a climate org, a climate campaign, a pro-climate political party)
* Support a climate campaign (e.g., sign or circulate a petition)
* Join educational events organized by a climate organization
* Vote for a political candidate/party proposing emission reduction policy
 |
|  | Advocacy | * Contact one’s representatives to ask them to enact emission reduction policies
* Collaborate with institutions and politicians to create emission reduction policies
* Give professional advice to institutions and politicians on emission reduction policies
* Join a climate organization that advocates for emission-reduction policies
* Start a new project, campaign, program, or group/organization to communicate/collaborate with politicians to enact emission reduction policies
 |
|  | Activism  | * Organize events such as demonstrations, petitions, sit-ins, or campaigns to put pressure on politicians to enact emission-reduction policies
* Attend events such as climate demonstrations, protests, sit-ins to put pressure on politicians to enact emission-reduction policies
* Join a climate organization that puts pressure on politicians to enact emission-reduction policies, via demonstrations, protests, sit-ins
* Start a new project, campaign, or group/organization to pressure politicians to enact emission reduction policies
* Take legal action against big emitters (companies or institutions)
 |
|  | Education  | * Speak to others about the climate crisis and emission reduction behaviors
* Circulate information about the climate crisis and emission reduction behavior on social media
* Organize educational events about the climate crisis
 |
| *Individual* | Food consumption | * Reduce meat consumption
* Reduce dairy consumption
* Eat seasonal products
* Eat local products
* Reduce food waste
 |
|  | Transportation | * Use means of transport that do not burn petrol (walking or cycling)
* Use public transports
* Substitute higher emission transports with lower emission ones (e.g. carpooling instead of driving alone, or carpooling instead of flying)
 |
|  | Energy use | * Shift to renewable energy sources
* Reduce electricity consumption (switching lights off, unplug appliances, reduce appliance use)
* Reduce energy consumption (reduce home heating and cooling, reduce water use)
* Reduce cooking gas use
* Limit online data storage and transfer
 |
|  | Finances | * Divest from fossil-fuel related services (e.g., move utilities provider from fossil-based energy providers to 100% certified renewable energy providers, move one’s savings from a fossil-tied bank to a credit union)
* Reduce the amount of unnecessary products bought
* Buy fewer high-quality products instead of many low-quality ones
* Buy products produced locally
 |

Coding List References:

* Individual behavior:
	+ Marchi et al., 2021
	+ Brandenstein et al., 2023
	+ Dietz et al., 2009
	+ Our World in data - Emissions by sector: <https://ourworldindata.org/emissions-by-sector>
* Collective behaviors:
	+ The Commons Social Change Library:  <https://commonslibrary.org/climate-activism-start-here/>

**FINAL SURVEY**

This will be like the Baseline Survey, but measuring

* the 12 psychological factors
* Anxiety

**FOLLOW-UP SURVEY**

This will be like the Baseline Survey, but measuring

* the 12 psychological factors
* Anxiety
* Behavioral Recall

**FOCUS GROUP**

(Example schedule)

The focus group will be carried out on Zoom through 1.30h sessions, with 10 participants at a time. Participants will be instructed to re-read their module diaries before the focus group and have them within reach during the session.

|  |  |
| --- | --- |
| **Introduction** | **Now I want to ask you some questions about your experience within this study.** |
| **1.**  | Can you think of any particular element of the intervention (module/activity/format/tutor’s approach) that inspired you to get more involved with climate action?  |
| **2.**  | Can you think of any particular element of the intervention (module/activity/format/tutor’s attitude) that was not as inspiring or left you feeling unsure about engaging with climate action? |
| **3.**  | Which behavioral category (individual or collective) you found particularly easy to engage in? And why? |
| **4.** | Which behavioral category (individual or collective) you found particularly difficult to engage in? And why? |
| **5.**  | Was there any topic or aspect of the climate crisis that you would have liked to learn more about? Or that you found redundant? Or any topic that was not there and you would have liked to learn about? |
| **6.**  | Do you have general suggestions on how to improve the intervention to make it more empowering for individual / collective climate action? |
| **In-depth: Questions for 1 - 2** | a. What exactly did you think about this module/activity?b. How exactly did you react/feel?c. Can you describe why this was so [inspiring/uninspiring]? d. In what ways did this alter your views on the climate crisis?  |
| **In-depth: Questions for 3 - 4** | a. What exactly made it easy/difficult to perform this behavior? b. Did you plan for it and failed to perform it, or did you simply not have opportunities to engage (and therefore did not plan for it)?c. For difficult behaviors: what do you think would make it easier for you to engage?  |

**Appendix B**

**Table of contents:**

* Intervention content table: modules title, factors targeted and activity description
* Intervention measures:
* Comprehension questions
* Short psychological questionnaires
* Module diary
* Example module 1: factors + contents and activities
* Incentives system

—--------------------------------------------------------------------------------------------------------------------

**INTERVENTION CONTENT TABLE**

**Supplementary Table 1.** *Intervention modules, with the respective psychological factors targeted and example activities used to boost each target factor. Existing interventions or theories related to the activities are referenced.*

|  |  |  |
| --- | --- | --- |
| **Module** | **Factors Targeted** | **Short activity description** |
| **Module 1:** **Intro to the climate crisis and climate action.** On the causes, impacts of the climate crisis, and on the psychological obstacles/incentives of mitigation behavior (3h) | Appraisal | Whole class. Interactive workshop on climate attribution analysis: understand how scientists know that increasing global temperatures lead to extreme weather in a given region (Nordlund & Garvill, 2003) |
| Emotional Engagement (risk, anger, empathy) | In groups: * Run a small research project on the extreme weather events that have increased in your region due to climate change
* View and discuss an anger consensus message about climate inaction (statistics are presented about a growing number of people being angry about climate inaction)

(van der Linden 2017; Castiglione et al., 2023; [Sabherwal et al., 2021](https://pdf.sciencedirectassets.com/272402/1-s2.0-S0272494421X00047/1-s2.0-S0272494421000931/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEJX%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJIMEYCIQDMcBZEM1wEZa7SdWVWbXmMcezNkWi8d1BFRDSCqNKxWwIhAI31BcTB2vF1gDo8s6bPAr4WW0NGZfThd9rhaRAZ%2Bns8KrwFCO7%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEQBRoMMDU5MDAzNTQ2ODY1IgwQBBFyt4taODmPeoMqkAXQ4XYfaTQrUCl9yqtecw%2BgQy0WxTd%2BnhIz2boAyKm9NGCXQs31CBZIbNQxx%2BTGyH1EicXj3DHUQD7b0hIs0pmsQhTFdCzupbp5kDpbWQtg4RviPcR%2FLnJigyftqMj7tf2Wq9S2hY9IhipBEPmQmx4Rh4at8F8oEa7nt61lvbkaqUpBQ2%2Fp5xhwVeJzREF9w4CSl9O9X7ihPRx005%2B78SRE7T9Ig5bI2wA5xoNmpbPD4wVohfEdrLUEZPCzIeM8GXdJ1AuNV%2BRjYCdSj%2BWZRc0H%2BWmFaLo6AklVsKlP6B1fdZvnUuun%2BcHvXWMtNPGD5g9qG7ATWqnzaOruiwsixiE1OeCdAPyw08Sy4DxineV1vHti1TAcEhNa0u2M2BMjocS6iJBpMC4VmwLfIu1ZmIciyacXFVgk5HAo5LoUF0rctW5bYXg7mzTShEyCX3fGRU%2BPyDGj%2Bs7uSYQTrHdNYEMzxOZhWxYDlyxwQA5MW%2FZi%2BSkWW%2BXBHllj4rzCj3uOUNfCJ4Db6%2BPqRghT6fLJ0AbRKy3CqZmaPJkPWPJvzd1lGpSP17Bx%2FGc3Eo%2B7TRVA884gA4lBn6WssS2Wg5LEo2CJzR2wA%2BFMdIV5ile7cv1cuaID6InBsYS%2BkBJ3ujj2g5oztzDWhob1ztAofmA%2B7qSwuC0FvB9Nnph%2BuBsN%2FLGnVxwMk%2FV9dTNgnNOApZltv7aE41gDNlEhJ3q6tRI2Sd71VuLWG4%2BmBLSEW5RTKfmne9GsdWxlkP4sQLtBrq0MPgeKvDUyzSURze7LtCPn21dRx4LJh8odhQ%2BKkvZ6a8OkuyPwjYKhwoT36zDHcMC3PVlC%2BXylVKPuQOtuw6wFfGsr0SxrbgKY0UO4KNvA87eH2zC6kKKrBjqwATOT9WAXjt3FAAnARjTD2WHDolrXc20XhkacCc1%2BVJ3mcA8l%2B0AaQ43b7Lsbp8LVtuOuboICzmQlQDyTMEhwy0I%2BQeHNHymF2BsLaZTWMmcIjQ1iCnhL%2Fp0QY2YeLgy8wqLJXN%2FwQ9XoboWaNqw4skplxz0S5rsgWjb%2BzUYKFE6OYjszG%2FnqVIpSq4x%2FjI9vjS4HvXfyWe2LO5RNNkerbjoBAXWIHCcF7%2FTdbVm55JP9&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20231130T140642Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY5TGH44NA%2F20231130%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=6703e7defa96bd348934157406110fc58545c0ad2b67111de2d66bb4914d1635&hash=28732de9ca5d4051525859183c92a65ff9b37d578e7e3d26a1984057a32a01ac&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0272494421000931&tid=spdf-bcb59738-36d5-464c-a219-24834093a4fb&sid=11ddc11564b13247116b39e25c3f739ee9d2gxrq)) |
| Self-identity | Alone + group discussion. Reflect on and discuss your environmental values and behaviors: * Values: what are nature and the environment to you? Are they important to your well-being? How and why do you believe they should be preserved? Are humans above or at the same level as the rest of the natural world? Let naturalistic values emerge
* Behaviors: how do you act on your values? What do you do / have you done to protect the environment? Think of any example in your life, and share it

(Mayer & Frantz 2004; [Lalot 2019](https://www.sciencedirect.com/science/article/pii/S0272494418303463?casa_token=JY2_5wzfvJMAAAAA:7kyqtbYlhHF2U3LSO0WsEG_ywY4NCHDp9kYbkFRCgER__90CHA7Q7iIGhWGysU1fZ-W7FhVS9A); [Lauren 2017](https://journals.sagepub.com/doi/full/10.1177/0013916517740408?casa_token=NFWvaNGjyScAAAAA%3AkWVQrdJA5SH8vSn36iPDXHjKnRd7WPsDyvv1qIP4PrDx2xQdvh8pciHa6D-MtQdFlRXOHMewns6X)) |
| Collective-identity | Whole class + group discussion. * Whole class. Watch a short documentary about famous climate advocates/activists close to the audience (like Fridays for Future or Sunrise movement leaders); emphasizing the bottom-up nature of their work.
* In groups. Analyze the advocates/activists’ motivations: why are they taking action? What are their psychological drives? What do you have in common with them (e.g. psychological drives, age, gender, background)? Can you see yourself among them? Would you be their friend? Can you define yourself as an environmentalist?

(Jans 2021; [Masson 2014](https://onlinelibrary.wiley.com/doi/full/10.1002/ejsp.2036?casa_token=3Ri5FKYNyI8AAAAA%3AT_jh6RIpBtOJQojjrxGPAYMBzp2vrYr5D33ubUObm37xSiAZAt4j7LWPBvXrTWAEUcIDgiEQd6Bpllw); Pettigrew & Tropp, 2006; Brick and Lai 2018) |
| **Module 2:****Decarbonization**. On the main greenhouse gasses, their anthropogenic sources, and how to cut them (3h) | Self Efficacy | In groups. * Run a small research project on how much emissions would decrease if every person: A. stopped eating meat, B. stopped using cars/planes, C. moved to renewable energy, D. only bought used things.
* Read and discuss materials (text and videos) about how young adults, through their civic engagement, have contributed to climate mitigation goals in Italy.
* Brainstorm: how can your individual actions affect others? Develop a communication strategy leveraging a psychological factors of your choice (learned form last time), to convince somebody around you to engage in a climate mitigation behavior that you do.

(Hamann et al., 2020; Jugert 2016; Hornsey 2022) |
| Social Norm | In groups:* Read and discuss statistics of what other young adults across the world think about climate action, and how they are increasingly taking more individual and collective climate action.
* Now that you have a better idea of the most impactful pro-climate behaviors, share all the individual and collective pro-climate behaviors you already do with the rest of your group. Tell others how you started engaging in these behaviors.

([Jachimowicz et al., 2018](https://www.nature.com/articles/s41562-018-0434-0); [Sparkman et al., 2020](https://www.mdpi.com/2071-1050/12/6/2453); [Nolan 2021](https://www.sciencedirect.com/science/article/pii/S2352250X21000701?casa_token=c63qLjF26AEAAAAA:XrXjwUua4_TqVnjqXVvicmpg5U3NjlAKx8hFZH3yQbwdFqzt-B2y2GIioh_KnzhqpClPW7b-Kg); Constantino et al., [2022](https://journals.sagepub.com/doi/full/10.1177/15291006221105279))  |
| Perceived Behavioral Control | In groups. Brainstorm tricks to perform complex pro-climate behaviors. 1) Select easily performed behaviors and reason on what makes them easy. 2) List difficult behaviors (e.g. habit change or civic engagement or activism). 3) Brainstorm similar non-climate-related difficult behaviors you already do in life (e.g. behaviors that require habit-change or exposure to the public). 4) Compare: what makes the difficult behaviors you already do feasible? How to transfer this to pro-climate difficult behaviors? (New) |
| **Module 3:****Climate Economics.** Shifting from a linear fossil economy to a circular economy (3h) | Appraisal | In groups. Run a small research project on fossil finance: how rich is the fossil fuel industry? Which major financial institutions are supporting it (banks, insurance companies…)? In which ways are you supporting it with your money?(Nordlund & Garvill, 2003) |
| Perceived behavioral control | In groups. Build a personal decarbonization plan to facilitate your own emission reduction. Set SMART goals for reducing your CO2 footprint from food, transports, energy and finances. Build a timeline by using a calendar, and nudging strategies for yourself and include a weekly-tracker so you hold yourself accountable. ([Steinmetz et al, 2016](https://psycnet.apa.org/fulltext/2016-52618-007.pdf?auth_token=45eabf07fc40764733c3c7e66050b204e9df4315&returnUrl=https%3A%2F%2Fpsycnet.apa.org%2Frecord%2F2016-52618-007); Fielding et al., 2008; ) |
| Implementation intentions | Alone. Build a “where, when, how” plan to implement your personal decarbonization plan (Gollwitzer 2006; [Steinmetz et al, 2016](https://psycnet.apa.org/fulltext/2016-52618-007.pdf?auth_token=45eabf07fc40764733c3c7e66050b204e9df4315&returnUrl=https%3A%2F%2Fpsycnet.apa.org%2Frecord%2F2016-52618-007)) |
| Cognitive Alternatives | In groups. Imagine picking an institution (a company, school, city) and imagine what it would look like if it was a 0-emission institution. How would energy work? And the food and transportation system? Where would its money be invested? Write a short essay describing the institution (Wright et al., 2020) |
| **Module 4:****System Change**. On how societal change can spread from local to global (3h) | Theory of Change | In groups. Run a small research project - pick an international social movement of the past (Civil Rights, LGBTQ+, women’s rights, anti-apartheid, anti-war, anti-regime…) and track its origin - who started it? Where was it started? How did it grow? What changed in society as a result? (New) |
| Collective Efficacy | Watch documentary on successful climate action, i.e. group of citizens convincing government or institution to enact some decarbonization procedure (e.g. Fridays for Future, Sunrise.org) and discuss together ([Bieniek-Tobasco et al., 2020](https://journals.sagepub.com/doi/10.1177/1075547020951794); Jugert 2016; Hamann 2020) |
| Faith in Institutions | In groups. Run a research project on political figures in the history of your country who have pushed for climate mitigation policy. Find success stories of political implementation of climate mitigation policies ([Feldman et al., 2015](https://journals.sagepub.com/doi/10.1177/1075547015617941))  |
| Cognitive Alternatives | Alone + group discussion: Imagine we have decarbonized our society. Write a short essay on what the world would look like in 2100 if we had stopped extracting and burning fossil fuels (Wright et al., 2020; Schmitt 2023) |
| **Module 5:****Civic engagement for climate, part I**.On how to create effective bottom-up change (3h) | Self Efficacy | Alone: Reflect on your skills: what are you good at? What do you like to do? E.g. speak in public, write, make art, plan, do research, use social media. How can you apply these skills to civic participation for a climate cause? What could be your role in a climate group/organization? (New) |
| Collective Efficacy | In groups. Divide into interest groups around a climate issue (transportation, food, finances, energy) and plan a climate mitigation campaign: identify a goal, a decision maker to convince to implement your goal (target), a strategy to convince the target, a timeline, distribute roles and responsibilities within your group, build a monitoring plan. Write a short report of your campaign. (Hamann et al., 2023; Gulliver et al., 2022) |
| **Module 6:****Civic engagement for climate, part II**.On effective team work for climate action (3h) | Collective Identity | In groups. * Guided brainstorm on team-work: what effective teamwork looks like? How to define roles? How to distribute responsibility? How to lead a group? How to be accountable?
* Applied laboratory: apply the team-work guidelines brainstormed above to your campaign group (get to know each other, define roles, distribute responsibility, define leadership and accountability guidelines…)
* Revisit your campaign plan (e.g. tactics, timeline, roles) based on your new team-work guidelines
* Group discussion. Do you feel closer to your group now that you are working as a real team? Do you feel you could have an impact if you kept working on this campaign?

([Lacerenza 2018](https://pubmed.ncbi.nlm.nih.gov/29792465/); Raue 2013) |
| Theory of Change | In groups. Make an impact analysis of your campaign: how can it escalate and diffuse change from the local to the global? (New) |
| Perceived behavioral control  | Alone. Build a “personal civic engagement plan” toincrease your collective pro-climate behaviors. Use a calendar, and nudging strategies for yourself and include a weekly-tracker to hold yourself accountable (Fielding et al., 2008; [Steinmetz et al, 2016](https://psycnet.apa.org/fulltext/2016-52618-007.pdf?auth_token=45eabf07fc40764733c3c7e66050b204e9df4315&returnUrl=https%3A%2F%2Fpsycnet.apa.org%2Frecord%2F2016-52618-007)) |
| Implementation Intentions | In groups. Make an implementation plan for your campaign: when, where and how can you really implement it? E.g. can you do it through a climate organization? Which one? How/when will you contact them to propose your idea? Alone. Build a “where, when, how” plan to implement your personal civic-engagement plan (Gollwitzer 2006; [Steinmetz et al, 2016](https://psycnet.apa.org/fulltext/2016-52618-007.pdf?auth_token=45eabf07fc40764733c3c7e66050b204e9df4315&returnUrl=https%3A%2F%2Fpsycnet.apa.org%2Frecord%2F2016-52618-007)) |

**INTERVENTION MEASURES**

***Comprehension questions***

There will be 4 comprehension questions for each module. 2 questions will be about the content from the 40-minute presentation, and 2 questions will be about the activities carried out during the module.

Example comprehension question for Module 1:

1. How does the greenhouse effect work?
	1. The greenhouse gasses in the atmosphere retain the infrared radiation emitted by the earth, warming up the bottom layer of the atmosphere and thus the earth surface
	2. The greenhouse gasses in the atmosphere retain the infrared radiation emitted by the sun, warming up the top layer of the atmosphere and thus the earth surface
	3. The infrared radiation emitted by the earth retains the greenhouse gasses in the atmosphere, warming up the earth surface
	4. The infrared radiation emitted by the sun retains the greenhouse gasses in the atmosphere, warming up the earth surface
2. Which kind of extreme weather has increased in Italy due to global warming?
	1. Floods
	2. Draughts
	3. Tornadoes
	4. Both a and b are correct
3. What was one of todays’ *activities* centered around?
	1. your emotions regarding climate change
	2. linear versus circular economy
	3. the carbon market
	4. climate policy
4. What was the other activity about?
	1. find out extreme weather in your region
	2. climatological modeling
	3. fast fashion
	4. consumerism

**SHORT PSYCHOLOGICAL QUESTIONNAIRES**

For each module, this will consist of a section of the baseline psychological questionnaire, including all the psychological factors targeted by the module (e.g. for Module 1, this will include Emotional Engagement and Appraisal questions).

**MODULE DIARY**

**At the end of each module, participants will be prompted to write a short diary page, responding to the following questions:**

1. Write a summary of what happened during today’s module (2 sentences)
2. What did you find motivating, encouraging, empowering about today’s:
	1. contents and activities? (1 sentence)
	2. format (e.g. time spent on the presentation or doing each activity) (1 sentence)
	3. tutor’s attitude (1 sentence)
3. What did you find boring, demotivating, disempowering about today’s contents and activities? (1 sentence)
	1. contents and activities? (1 sentence)
	2. format (e.g. time spent on the presentation or doing each activity) (1 sentence)
	3. tutor’s attitude (1 sentence)
4. How can you use what you learned today to increase your individual and collective pro-climate behaviors? (2 sentences)

**INCENTIVE SYSTEM AND EXCLUSION**

***BASELINE + FINAL***

**Experimental group**

Participants will start with 0 points and can earn up to 134 points. They will earn proportionally to the effort and time spent on the corresponding task, as follows:

* 1 point for every EMA survey completed (x28 days)
* 0.5 points for every correct answer to a module comprehension question (x24 questions)
* 10 points for every meeting they attend (x6 meetings)
* 10 points for participating in the focus group (x1 focus group)
* 3 points for every module short-psychological questionnaire (x6 questionnaires)
* 1 points for every homework they complete (x6 homework)

At the end of the study, all participants reaching a 120 score-threshold will enter a raffle; out of these, 3 randomly selected participants will win a prize worth about 150 euro (which will vary from a cash reward to a gift card, depending on the audience).

**Control group (Study 1):**

Participants will start with 0 points and can earn up to 38 points. They will earn points in the following ways:

* 1 point for every EMA survey completed (x28 days)
* 10 points for participating in the focus group (x1 focus group)

All participants reaching a 30 score-threshold will enter a raffle; out of these, 3 randomly selected participants will win a prize worth about 50 euro (which will vary from a cash reward to a gift card, depending on the audience).

***FOLLOW-UP***

**Experimental and control group**

Participants will start again with 0 points and can earn up to 24 points. They can only win this prize if they were not excluded from the study at the final stage. They will earn points in the following ways:

* 1 point for every EMA survey completed (x14 days)
* 10 points for responding to the follow-up psychological questionnaire

All participants reaching a 15 score-threshold will enter a raffle; out of these, 2 randomly selected participants (per condition) will win a prize worth about 50 euro (which will vary from a cash reward to a gift card, depending on the audience).

**Participants will be informed that they will be excluded from the study if:**

* They fail to complete more than 5 daily surveys (out of 14), in any of the initial and final EMA behavioral tracking stages
* They fail to fill any one of the baseline and final psychological questionnaires
* They fail to attend more than 2 out of 6 intervention meetings (experimental participants only).