Action planning interventions to promote individual and collective climate action

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Abstract

People are increasingly concerned about climate change but under-engaged in climate action, especially collective action. Online interventions can support action planning and behavior change in contexts including pro-environmental behavior. However, psychological interventions have tended to focus on individual-level climate action, and we do not yet know how effective they are for collective actions. We tested whether action planning interventions based on mental contrasting with implementation intentions and episodic simulation could increase intentions to engage in individual (e.g., driving less) and collective (e.g., contacting elected officials about climate change) climate actions. Participants were randomly assigned to an individual action planning (IAP) intervention, a collective action planning (CAP) intervention, or a no-intervention control group, and rated intentions to engage in individual and collective pro-environmental behaviors after completing the intervention. Preregistered analyses (on N = 1,586 participants) showed that compared to the control group, both action planning interventions increase targeted pro-environmental behaviors. Furthermore, these effects spilled over to other (non-targeted) pro-environmental behaviors, but spillover effects only occurred within action types (individual vs. collective). CAP also had greater overall effects on the perceived impact of actions, including individual actions. This study extends prior theorizing about the psychology of action planning to incorporate collective actions and provides practical insights to bridge the gap between climate concern and engagement in coordinated climate initiatives.

Keywords

Mental contrasting, action planning, intervention, collective action, climate change, climate action

Highlights

- Collective action is necessary to mitigate and adapt to climate change
- We adapted action planning tasks to promote individual or collective climate actions
- Both action planning tasks increased intentions to engage in a target action
- Task spillover effects are category specific (collective vs. individual)

Introduction

A growing majority of Americans are concerned about climate change, but there is a gap between their attitudes and actions (Tyson et al., 2023; Bell et al., 2021; Tyson et al., 2021; Funk & Hefferon, 2019; Ballew et al., 2024). Many of those who are concerned about the consequences of climate change either do not engage in climate change mitigation or adaptation efforts, or they engage primarily in low-impact, individualized behaviors such as recycling (Leiserowitz et al., 2024; Leiserowitz et al., 2023; Selig and Guskin, 2023; Truelove and Parks, 2012; Whitmarsh, 2009). Although individual actions like reducing waste or home energy use are insufficient to address climate change, far fewer people engage in the collective action or conversations needed to drive systemic change (Whitmarsh et al., 2021; Calvin et al. (IPCC), 2023; UNEP, 2020; Leiserowitz et al., 2023; Leiserowitz et al., 2024).

Collective action involves achieving shared goals through systemic change (Ostrom, 2004; Holahan & Lubell, 2016), and requires coordinated actions by individuals to succeed. At the individual level, collective action can take many forms, such as voting, signing petitions, participating in community initiatives, or organizing events and campaigns to influence policy. Calls for collective action often focus on these specific activities (e.g., contacting representatives) or broader objectives (e.g., transitioning to renewable energy). However, these calls can feel abstract, representing a sequence of more specific behaviors that may not seem immediately actionable to individuals. Making collective goals more concrete and actionable for individuals may therefore be essential for catalyzing participation. We hypothesize that if individuals could visualize collective action as a series of steps leading to a desirable future, they would be more likely to engage, thus narrowing the gap between attitudes and behaviors.

A vast literature on action planning, goal pursuit, self-regulation, and motivation has highlighted that psychological interventions that entail imaginative action planning, or that increase the concreteness of a desired future outcome (episodic simulation, or vivid imagination of the future) as well as the steps necessary to achieve the goal (action planning) can promote individual behavior change (Wang et al., 2021, Cross & Sheffield, 2017; Gollwitzer, 1999; Gollwitzer & Sheeran, 2006; Oettingen & Gollwitzer, 2010; Kirk et al., 2013; Ort & Fahr, 2022, Loy et al., 2016; Mutter et al., 2020). One such intervention is mental contrasting with implementation intentions (MCII), an action-planning task that has been widely demonstrated to enhance self-regulation and improve goal attainment (Gollwitzer, 1999; Gollwitzer & Sheeran, 2006; Oettingen & Gollwitzer, 2010; Kirk et al., 2013). In addition to prompting individuals to consider the process by which they can achieve their goals, MCII also leverages episodic simulation, an imagination process that plays a key role in decision making (e.g., Schacter, Addis, & Buckner, 2008; Gaesser, Yuki, & Cikara, 2020). MCII engages simulation processes by prompting people to imagine and describe the best possible outcomes of engaging in a goal behavior (e.g., Mutter et al., 2020; Ort & Fahr, 2022, Loy et al., 2016). Through this process, individuals can increase the concreteness, actionability, and short-term relevance of desired futures, making goals and the path to achieve them more salient. Although this type of action-planning intervention has been applied to a variety of domains, the majority have focused on health behavior change (Mutter et al., 2020; Ort & Fahr, 2022), and prior studies on pro-environmental behaviors have exclusively focused on individual-level lifestyle changes, such as dietary habits (e.g., Loy et al., 2016).

In this study, we test the effects of an action planning intervention on individual and collective pro-environmental action intentions. Using a between-subjects design in an online study, we test action

planning interventions where participants imagined an action plan, the best possible outcomes of an action, an obstacle they might face, and how to overcome the obstacle (Oettingen and Gollwitzer, 2010; Kirk et al., 2013) for either an individual action (IAP) or a collective action (CAP) against a no-intervention control group, measuring intentions to engage in both collective and individual action intentions in all three of these conditions. In a series of pre-registered analyses, we tested how effectively our interventions increased targeted behavioral intentions (H1), whether effects spilled over to other, non-targeted pro-environmental behaviors (H2), and whether spillover effects were stronger within-category (collective vs. individual action intentions, relative to the intervention condition). We also explored intervention effects on the perceived impact of pro-environmental behaviors if many people did them (i.e., collective efficacy; Bandura, 2000). In this paper, we provide the results of our pre-registered analyses as well as secondary and exploratory analyses.

Methods

This study was part of a larger project that tested a variety of intervention strategies to promote climate action. Details about the larger study are included in a separate report ([redacted for review]). The larger study's standard operating procedures are here: [OSF link redacted for review]. This paper is unique from the broader project report in that it focuses distinctly and solely on the action planning interventions, including detailed analyses of outcomes and condition comparisons not included elsewhere. The analyses in this manuscript were pre-registered [OSF link redacted for review]. All procedures in this study were carried out in compliance with ethics laws and guidelines for human subjects research and were approved by the Institutional Review Board at [institution redacted for review]. All participants provided informed consent at the time of participation.

Participants

We aimed to have 400 participants in each experimental condition (IAP, CAP) based on *a priori* power analyses, conducted as part of the larger project. Since this experiment was part of a larger study comparing several interventions to the same control group, we aimed to have twice as many control participants (n = 800) for higher precision in this control group. Anticipating exclusions, we recruited more participants than our target sample size. Participants were recruited via Prolific in February 2024 and randomly assigned to either an intervention group or the control group in a between-subjects design. Participants were required to meet eligibility criteria; the details of these requirements and the sampling stratification are included in Supplemental Materials. Participants were excluded if they failed attention checks (n = 1) or if they reported denial of anthropogenic climate change either or indicated high uncertainty and skepticism about climate change (n = 27).

After exclusions, the total sample size was 1,625, with 393 in the IAP group, 382 in the CAP group, and 850 in the control group. The mean age for the final sample was 40 years (SD = 14), with 51% women, 46% men, and approximately 2.8% identifying as nonbinary, genderqueer, agender, gender fluid, or had an unlisted gender identity, and 0.4% preferring not to answer. Eleven percent of the final sample identified as Hispanic or Latinx (89% identified as not Hispanic/Latinx). Thirteen percent of participants identified as Black or African American, 70% as White, 3.5% as East Asian, 0.4% American Indian or

Alaskan Native, 2% South Asian, and 2.3% Southeast Asian. An additional 6.2% listed multiple races, and 2.2% preferred not to say or had an unlisted racial identity. Education and income distributions are included in Table 1. Age, gender, race, ethnicity, income, education, subjective socioeconomic status, political ideology, and political party affiliation did not differ between groups as per χ^2 tests (included in Supplementary Materials).

Table 1. Demographics of sample

Variable	*N (%)*	Variable	*N (%)*
Gender		Education level	
Agender, gender fluid, or genderqueer	19 (1.2%)	Did not complete high school	12 (0.8%)
Man	751 (46%)	High school graduate (GED)	45 (3.0%)
Gender identity not listed	2 (0.1%)	Some college (1-4 years, no degree)	329 (22%)
Non-binary	29 (1.8%)	Associate's degree (including occupational or academic degrees)	156 (10%)
Woman	821 (51%)	Bachelor's degree (BA, BS, etc)	657 (44%)
Age	40 (14)	Master's degree (MA, MS, MENG, MSW, etc)	226 (15%)
Race/Ethnicity		Professional school degree (MD, DDC, JD, etc)	34 (2.3%)
American Indian or Alaskan Native	6 (0.4%)	Doctorate degree (PhD, EdD, etc)	33 (2.2%)
Black or African American	212 (13%)	Income level	
East Asian	57 (3.5%)	Less than $5,000	32 (2.0%)
Multiple races	100 (6.2%)	$5,000 through $11,999	48 (3.0%)
Native Hawaiian or Other Pacific Islander	3 (0.2%)	$12,000 through $15,999	39 (2.5%)
Racial/ethnic identity not listed	26 (1.6%)	$16,000 through $24,999	81 (5.1%)
South Asian	32 (2.0%)	$25,000 through $34,999	147 (9.3%)
Southeast Asian	37 (2.3%)	$35,000 through $49,999	210 (13%)
White	1,142 (70%)	$50,000 through $74,999	325 (20%)
Hispanic/Latinx		$75,000 through $99,999	271 (17%)
No	1,441 (89%)	$100,000 through $149,999	257 (16%)
Yes	178 (11%)	$150,000 and greater	176 (11%)
Variable	*Mean (SD)*		
Subjective social status (10-pt scale)	5.00 (2.00)		

We used a mouse-tracking tool (TaskMaster) to track off-task behavior, which may indicate distraction or the use of external tools like ChatGPT Participants were informed about the use of mouse-tracking and were asked not to use external aids during the task. We excluded participants who spent a greater time away from the experiment than on the experiment page, specifically on pages with writing prompts (n = 17). At the end of the survey, we also asked participants to self-report dishonesty, distraction, or other issues during the study. Participants were excluded from analysis if they reported using external aids (e.g., Google or ChatGPT) to complete the task, or if they reported answering

dishonestly or not taking the survey seriously (*n* = 7). Some participants were excluded for multiple reasons (n = 3).

Finally, we excluded participants who provided poor-quality responses to open-ended writing components (*n* = 6), defined as one or more of: entering random text that is not related to the prompt, copying and pasting the prompt itself, entering the same text for every prompt, or entering text that does not make logical or grammatical sense (e.g. "I have nothing to say about this", "N/A i Recycle right", "I think this pukes me so much"). These text quality assurances were performed using the large language model GPT-4. For each participant, we prompted the model with the writing prompts, the participants' responses, and a set of instructions for evaluation. We first tested the reliability of our usage of GPT-4 by manually coding data from roughly 300 participants. GPT-4 and human raters assigned each written response a quality score ranging from 1 (very low quality) to 10 (very high quality), considering the length, relevance, detail, and grammar of the responses. Using these continuous quality scores, we calculated the inter-rater intra-class correlation coefficient between GPT-4 and human ratings to assess reliability; ICC scores indicated "moderate" agreement (ICC = 0.46). We then used GPT-4 to screen for low-quality responses in the full dataset. We manually reviewed all responses that were flagged for exclusion or assigned low quality scores (≤3 of 10), as well as outliers with unusually high or low word count.

Task design

Participants were randomly assigned to either a no-task control condition or one of two experimental conditions. In all groups, participants selected a target climate action behavior from a pre-set list, indicating which action from the list they could most easily see themselves doing more or starting to do.

In the **Action Planning conditions**, participants were provided the following prompt: "While there are many ways to do good for [yourself/your community] and the environment, world experts (e.g., the UN Environment Programme) recommend we [change certain habits to make more sustainable choices / engage in collective action to help bring about more sustainable systems]." Participants were then asked to choose which of a list of behaviors they could most see themselves doing more in the future.

In the **Individual Action Planning condition**, participants selected an individual-level climate action that they could most see themselves from the following list: driving less, flying less, paying for green energy at home, eating less red meat, or eating more vegetarian or vegan meals. To ensure that individual action options were high-impact, we conducted separate preliminary surveys to identify feasible pro-environmental behaviors that were not at ceiling for most participants ([redacted for review]), and selected the subset of these behaviors that were associated with relatively high mitigation potential in terms of estimated reduction of greenhouse gas emissions (Ivanova et al., 2020).

In the **Collective Action Planning condition**, participants were first provided with a list of example initiatives that can be achieved through collective actions: "Government support to improve buses, trains, and other public transportation; Government support in paying for electric cars; Building more safe and enjoyable bike lanes and sidewalks; Government support paying for clean energy like solar power; Supporting local farmers or businesses by giving them government help; Making new green

spaces like gardens for everyone; Starting or changing programs to turn food scraps into soil (composting); Starting or changing programs to stop businesses from wasting food or giving extra food to people who need it." Then, participants selected the behavior they could most see themselves doing from the following list: contacting representatives about climate change, having conversations about climate change, donating to environmental organizations or campaigns, signing climate change related petitions, or volunteering for environmental organizations or campaigns.

In the **Control condition**, participants were provided the same question for both individual and collective actions, and selected one behavior from each list. In the experimental conditions, participants went on to complete a guided imagination and planning exercise regarding their choice action.

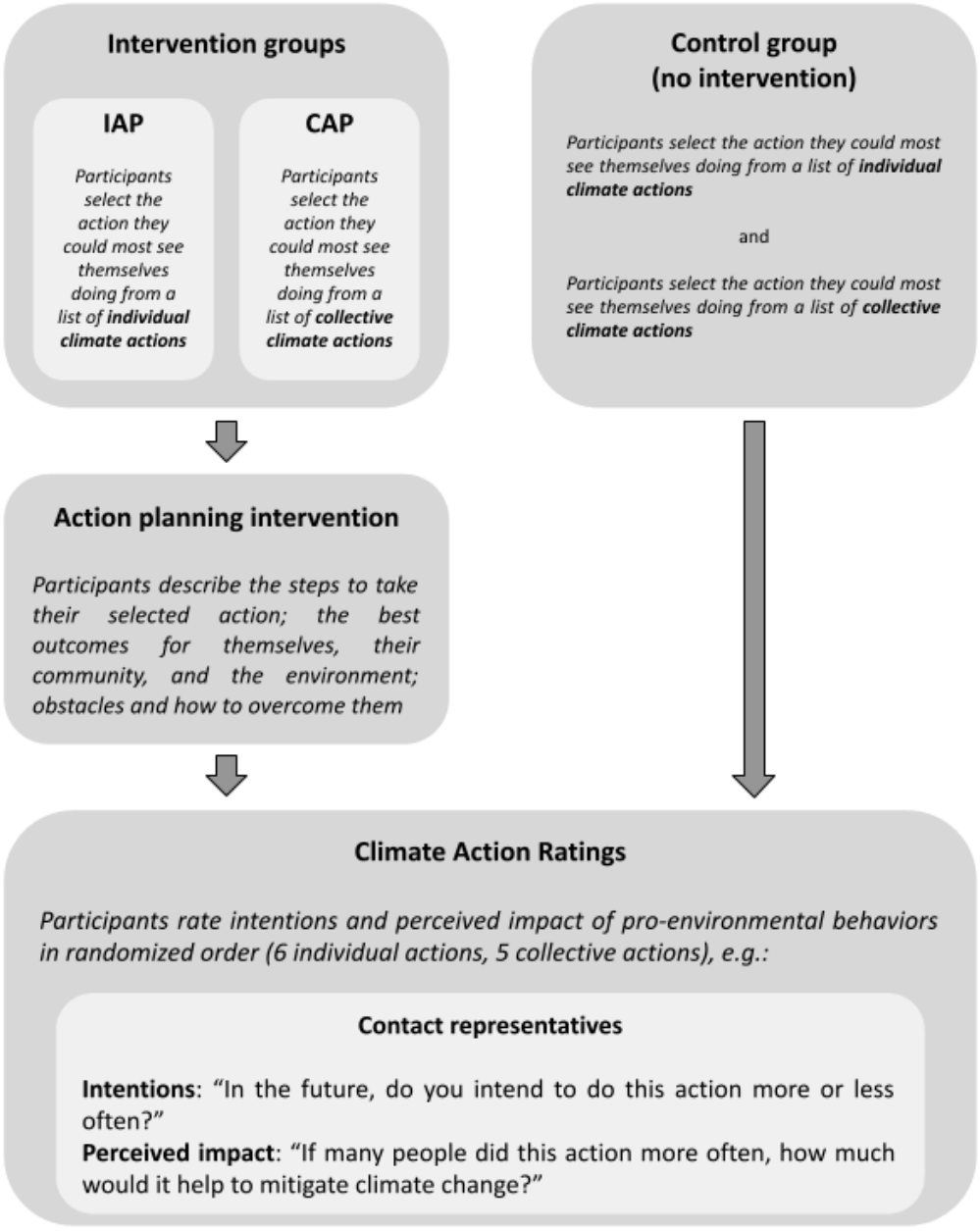
In both experimental conditions, participants were asked to consider it a personal goal to engage in the selected action, and to clearly imagine a future in which they take this action. In particular, participants were asked to first imagine engaging in the action, including how, when, where, and with whom they would engage in the action. Next, participants were asked to imagine the best possible outcomes of the action for themselves, their community, and the environment. Then, participants were asked to concretely imagine the steps necessary to begin engaging in the action as if imagining taking the action immediately. Finally, following the MCII approach, participants were asked to consider the biggest obstacle that could prevent them from engaging in the action, and to develop an if-then plan for overcoming this obstacle. At the end of the exercise, participants were asked to review and read aloud an overview of their responses to each prompt.

This task differs from the traditional MCII framework (Oettingen and Gollwitzer, 2010; Kirk et al., 2013) in several ways. First, participants choose a future pro-environmental behavior *as* their goal, rather than considering the behavior as the means to a higher-order goal. Second, to ensure participants focused on high-impact pro-environmental actions as goals, participants selected a goal behavior from pre-set options, rather than constructing and writing in their own goal as the task has previously been implemented. In a new addition to the MCII framework, we incorporated an element of episodic simulation (Schacter, Addis, & Buckner, 2008) by asking participants to concretely imagine engaging in the action, and specifically to describe the very first step to the process to maximize the concreteness of the action sequence. Finally, we asked participants to consider not only the best possible outcomes for themselves, but also for others, and for the environment. Thus, our intervention entails a novel formulation of well-established psychological tools for behavior change.

Primary outcome measures

Climate Action Ratings. As described in Figure 1, all participants were asked to provide ratings about 12 climate-relevant actions. These included seven individual-level actions (eating beef or lamb, eating vegetarian meals, eating vegan meals, driving a fuel-powered vehicle, flying by airplane, recycling, and paying for renewable energy for one's home) and five collective actions (donating, volunteering, signing petitions, contacting representatives, and talking to others about climate change). All actions were presented one at a time in a randomized order to each participant.

Figure 1. Overview of methods



Note. Participants were randomly assigned to one of three conditions: individual action planning (IAP), collective action planning (CAP) or a no-intervention control group. Participants selected an action from a list that they could most see themselves doing in the future. IAP participants selected an option from a list of individual actions, CAP participants selected an option from a list of collective actions, and control group participants selected an option from each list. After selecting an action, participants in the intervention groups completed the action planning exercise with respect to their chosen action. All participants then completed an outcome measure regarding intentions and perceived impact of a variety of pro-environmental behaviors. All participants then completed additional secondary outcome measures, described in Supplemental Materials.

For each action, participants reported their current frequency of engaging in the action. To describe current air travel habits, participants reported the number of flights taken in the past year, across six duration categories ranging from very short flights (under 2 hours) to extremely long flights (greater than 15 hours). To describe current donation behavior, participants input a number to approximate the total sum (in USD) that they donated in the past year to support organizations or candidates that aim to address climate change. To describe current payments for renewable energy, participants input an approximate amount (in USD), if any, that they currently pay to their electricity provider to power their home with renewable energy. For dietary actions, recycling, and driving, participants reported current frequency on a 9-point scale (1 = *Never*, 9 = *Multiple times per day*). For collective actions (with the exception of donations, described above), participants used a similar 9-point frequency scale (1 = *Never / Almost never*, 9 = *Every day*). Flights (count), paying for renewable energy (dollar amount), and donations (dollar amount) are winsorized to the 99th percentile.

For each action, participants used 7-point scales to rate their intentions to engage in the action more/less in the future (1 = *A lot less*, 7 = *A lot more*), according to which direction would be aligned with pro-environmental impact (e.g., eating less red meat, driving less, eating more vegan meals). Participants also rated the perceived environmental impact if many people did the action more/less often (1 = *No impact*, 7 = *Very large impact*). For additional measured variables, please see **Supplementary Materials.**

Statistical analysis

Statistical modeling. Models were fit using *lme4* (Version 1.1-26; Bates et al., 2015) and *lmerTest* (Version 3.1-3; Kuznetsova, Brockhoff, & Christensen, 2017) in R (Version 3.6.3; R Core Team, 2020). More details are included in the preregistration ([OSF link redacted for review]).

We first tested the most direct replication of prior action planning research: does engaging in an action planning task lead to higher intentions to engage in the specific chosen pro-environmental action (H1: target action intention effects)? For the H1 tests, we employed an OLS linear model with the explanatory variable being the general condition (action planning vs. control) and the outcome variable being behavioral intentions. For this test, we focused only on the action each participant indicated they could most envision themselves performing more frequently (target action). To address the fact that participants in the control condition provided two responses (selecting one action from each list of individual and collective actions), we divided the analyses into two separate models, each testing one condition-matched goal type (collective vs. individual action). Specifically, for the individual action planning (IAP) vs. control comparison, the dataset included only behavioral intentions for the individual-level action that IAP and control participants felt they could most see themselves doing. For the collective action planning (CAP) vs. control comparison, the dataset comprised only behavioral intentions for the collective action that CAP and control participants felt they could most see themselves doing. Our pre-registration initially specified using a single model across all groups. However, implementing this would necessitate duplicating data from control participants. The appropriate model would subsequently employ a multilevel model, which would also deviate from our pre-registered analysis. Although the pre-registered analysis is thus not included in this paper, the results are consistent

with those derived from the models we included in the final analysis. Model syntax for analyses included in the results are shown in Supplementary Materials.

For H2 (general intention effects), we fit a multi-level linear model where the outcome variable was behavioral intentions (including all rated actions; 12 per participant) and the explanatory variable of interest was general condition (action planning vs. control), including random intercepts for each participant to account for the fact that ratings for different actions were nested within participants. We included current frequency of engaging in each action as a covariate. In an exploratory follow-up test, we looked at the effect per specific condition (IAP, CAP, and control) as the explanatory variable of interest. In our pre-registered analysis plan, we specified that we would include the target action in these analyses. In Supplementary Materials, we show the general effects (H2) excluding the target action for each participant (that is, only non-targeted pro-environmental behaviors).

For H3 (within-category intention effects), we used two separate models. We first tested intervention effects on only individual level action intentions. In this model, we compare the main effects of group (IAP, CAP) against the control group as the reference category. We predicted that IAP but not CAP would have a positive and significant coefficient. Second, we tested intervention effects on only collective level action intentions. Similarly, we compare the main effects of group (IAP, CAP) against the control group as the reference category. We predicted that CAP, but not IAP, would have a positive and significant coefficient. Note, in this analysis, we also controlled for current engagement level in each action, and we included random intercepts for each participant to account for the fact that ratings for the different actions were nested within participants. In Supplementary Materials, we also show versions of these models excluding the target action for each participant. The models included in this paper differ from our pre-registered analyses. In our pre-registered analysis plan, we specified two models testing a main effect of group and an interaction between group and action category. While the preregistered models yield comparable results, the included models are more easily interpretable.

As a robustness check, we additionally ran all analyses excluding participants whose current level of engagement in pro-environmental actions was already at ceiling for a given action (percent of observations per action: recycling = 44.8%, driving = 11.7%, vegan = 3.5%, having conversations = 2.2%, volunteering = 0.5%, signing petitions = 0.4%, contacting representatives = 0.4%). Results were quantitatively and qualitatively comparable to analyses not excluding these participants.

In an exploratory follow-up to this hypothesis test (H3), we investigated intervention effects at the level of action intentions per action item. For this analysis, we use estimated marginal means (EMM) to determine contrasts between each condition for each action item. For our exploratory analyses testing intervention effects on the perceived impact of pro-environmental actions, we followed the same procedures as H2 and H3 tests, using perceived impact as the outcome variable.

Dependent variables were z-scored across all observations to standardize the effect sizes. Statistical significance will be determined based on an alpha level of $p = 0.05$. In models predicting action intentions, current frequency was also z-scored within-item and included in statistical models as a covariate. We preregistered that we would include demographic variables in hypothesis tests if they differed across conditions. No significant differences were found between groups for age, race, gender, ethnicity, income, education level, political ideology, or political party affiliation as per chi-squared tests for categorical variables and an ANOVA to test for group differences in age. Details are included in Supplementary Materials.

We also used Pearson's chi-squared tests to determine differences between control and intervention groups regarding the pro-environmental behavior they selected in the initial task prompt (choice action). To determine which actions differed between groups, post-hoc tests used adjusted residuals with an uncorrected significance threshold of $p < .05$.

Results

Descriptive statistics (mean and standard deviation) for action intentions and current action levels are included in Table 1. Additional descriptive statistics and visualizations can be found in Supplementary Materials. Model details for all hypothesis tests can be found in Table 3.

Table 2. Means, SDs, and Correlations Among Outcome variables

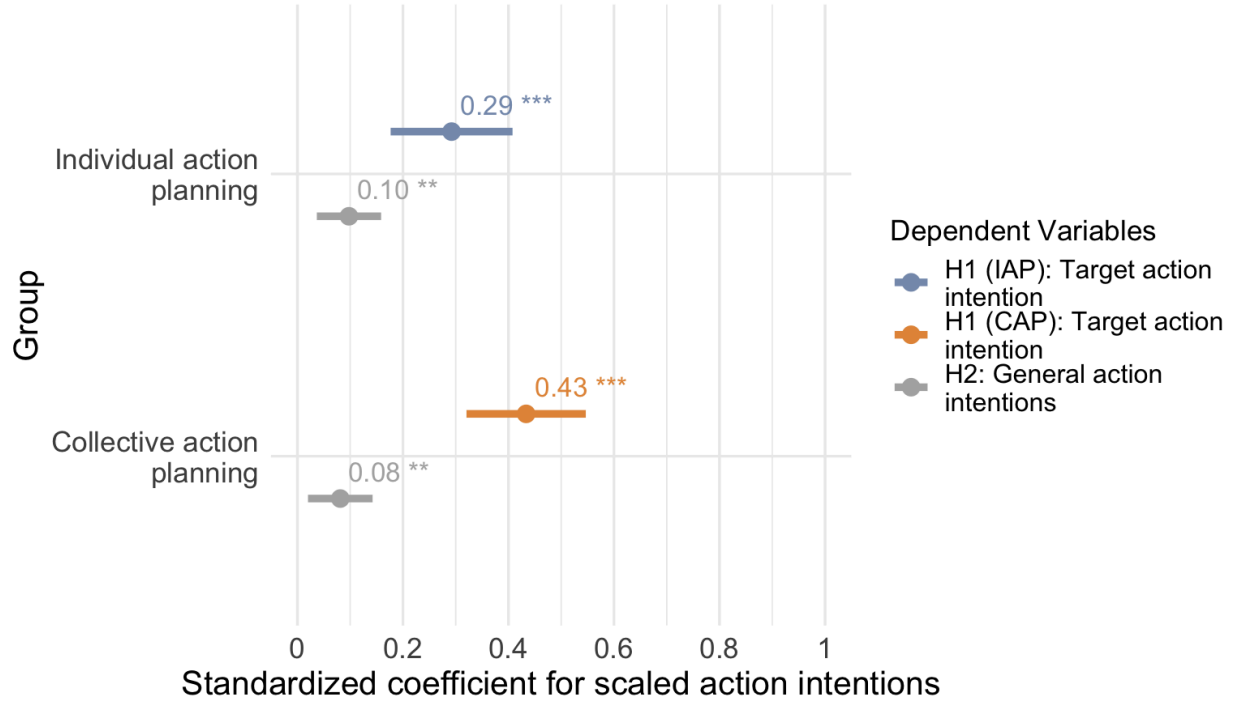
	Control		*IAP*		*CAP*	
Action	Current level	Future intentions	Current level	Future intentions	Current level	Future intentions
Recycling	7.06 (2.53)	4.83 (1.12)	7.03 (2.55)	4.91 (1.25)	7.11 (2.46)	4.88 (1.22)
Driving	6.69 (2.64)	4.13 (1.08)	6.86 (2.51)	4.26 (1.14)	6.39 (2.69)	4.2 (1.11)
Flights (estimated CO2 emissions)	833.63 (1480.16)	3.81 (1.01)	787.1 (1268.71)	3.88 (0.98)	789.14 (1363.99)	3.85 (1.03)
Vegan meals	3.68 (2.47)	4.36 (1.04)	3.71 (2.35)	4.56 (1.14)	3.71 (2.49)	4.32 (1.14)
Vegetarian meals	4.89 (2.6)	4.57 (1.06)	4.81 (2.54)	4.76 (1.14)	4.83 (2.6)	4.51 (1.12)
Eating meat	5.35 (2.01)	4.29 (0.92)	5.54 (1.86)	4.63 (1.13)	5.25 (2.11)	4.27 (0.89)
Paying for clean energy ($USD/month)	7.42 (31.3)	4.84 (1.17)	8.03 (34.36)	4.97 (1.12)	11.25 (40.5)	4.77 (1.18)
Volunteering	1.59 (1.46)	4.25 (1)	1.48 (1.33)	4.22 (1.03)	1.84 (1.65)	4.47 (1.12)
Petition	2.47 (1.8)	4.51 (1.03)	2.39 (1.75)	4.51 (1.05)	2.76 (1.78)	4.69 (1.07)
Donating ($USD/year)	24.71 (90.67)	4.43 (0.93)	24.42 (91.21)	4.48 (0.88)	34.19 (109.04)	4.62 (1.13)
Contacting representatives	1.7 (1.52)	4.27 (1.02)	1.67 (1.42)	4.32 (0.97)	1.9 (1.6)	4.5 (1.02)
Conversations	4.63 (2)	4.48 (0.93)	4.56 (2.2)	4.53 (0.94)	4.89 (1.95)	4.75 (1)

Note. Table shows mean (SD) for current level of engagement and future intentions for each action measured. These data are also visualized in Supplementary Materials. For all actions except flights (in estimated kilograms of CO2 emissions), paying for clean energy (in USD) and donation (in USD), current action levels reflect responses on a 9-point frequency scale (1 = *Never*, 9 = *Every day* for collective actions or or *Multiple times per day* for individual actions). All future intentions reflect responses on a 7-point scale of engaging in the action more/less in the future (1 = *A lot less*, 7 = *A lot more*). Flights, donations, and payment for clean energy are winsorized to the 99th percentile.

H1: Intervention effects on intentions for specific, participant-selected actions

We first tested whether participants reported higher intentions to engage in the target pro-environmental action they chose to focus on in the action planning task **(H1: target action intention effects)**. We find strong support for this first hypothesis. Individuals who completed an action planning task reported higher intentions to engage in their chosen behavior than participants in the control group who simply selected a behavior that they could most see themselves doing in the future, but did not engage in any action planning. This was true for both individual action planning (β = 0.26, CI = 0.13 – 0.39, p < 0.001), and collective action planning (β = 0.43, CI = 0.32 – 0.55, p < 0.001). In a post-hoc *z*-test (calculating the *z*-score of the difference in coefficients), we found that the difference in effects between CAP and IAP is not significant (difference = 0.14, z = 1.72, p = 0.09).

Figure 2. Intervention effects: target action (H1) and general effects (H2)



Note. Individual action planning (top) and collective action planning (bottom) as predictor variables for action intentions. Figure shows standardized regression coefficients compared to the control group with 95% CIs. In gold: the specific action participants chose for the action planning task (H1). In grey: General pro-environmental intentions across all measured action intentions (H2).

H2: Generalized intervention effects on action intentions

Next, we tested whether the intervention effects generalize to impact people's intentions to perform other pro-environmental behaviors that were not specifically the focus of the action planning task. We predicted that participants would report higher overall pro-environmental behavioral intentions, averaged across all behaviors, after engaging in action planning for their chosen behavior **(H2: general intention effects).** Consistent with this hypothesis, participants completing either action

planning intervention reported significantly higher intentions to engage in pro-environmental behaviors, collapsing across all measured actions (β = 0.09, CI = 0.04 – 0.14, p < 0.0001). In a follow-up analysis looking at each action planning condition, this effect is significant for both individual action planning (β = 0.10, CI = 0.04 – 0.16, p = 0.002) and collective action planning (β = 0.08, CI = 0.02 – 0.14, p = 0.009; see **Figure 1**). As per our pre-registered analysis plan, these effects include the target action. Results for this analysis, excluding the target action (looking only at non-targeted pro-environmental behaviors), produce similar conclusions, and can be found in Supplementary Materials.

Table 3. Model summaries for H1 and H2 tests

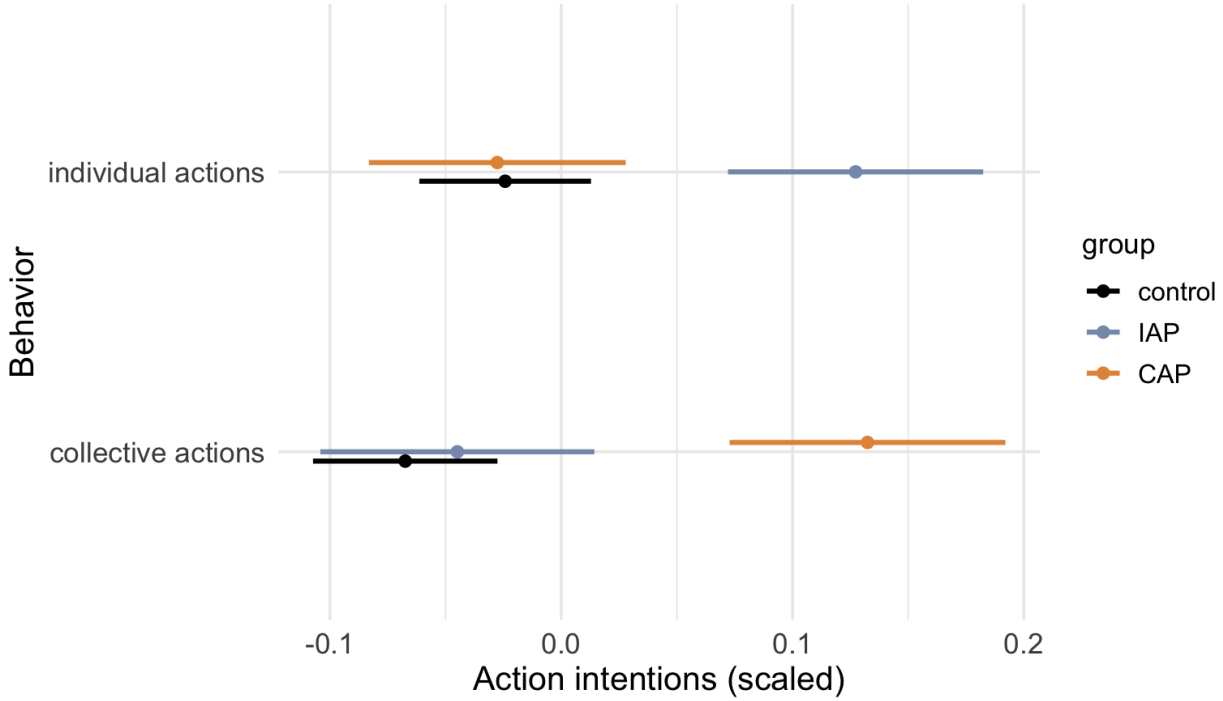
DV	*N*	Marginal R^2 / Conditional R^2	*Variable*	*Estimate*	*CI*	*Statistic*	*p*
H1: IAP target action intentions	1511	0.016 / 0.015	Intercept	0.27	0.21 – 0.33	8.24	<0.001
			Group (IAP)	0.29	0.18 – 0.41	4.96	<0.001
H1: CAP target action intentions	1208	0.045 / 0.044	Intercept	0.15	0.09 – 0.22	4.82	<0.001
			Group (CAP)	0.43	0.32 – 0.55	7.53	<0.001
H2: general intentions	1586	0.015 / 0.198	Intercept	-0.04	-0.08 – -0.01	-2.44	0.015
			Group (IAP or CAP)	0.09	0.04 – 0.14	3.56	<0.001
			Current action level	-0.11	-0.13 – -0.10	-16.83	<0.001
H2 *post-hoc*: general intentions	1586	0.015 / 0.198	Intercept	-0.04	-0.08 – -0.01	-2.44	0.015
			Group (IAP)	0.10	0.04 – 0.16	3.15	0.002
			Group (CAP)	0.08	0.02 – 0.14	2.61	0.009
			Current action level	-0.11	-0.13 – -0.10	-16.83	<0.001

Note. Estimates are standardized regression coefficients and statistics are t-values.

H3: Effects on intentions for collective vs. individual action types

We also hypothesized that the interventions would have greater effects on within-category action intentions, meaning that collective action planning would specifically increase collective action intentions relative to individual action planning and control groups, whereas individual action planning would increase individual action intentions relative to collective action planning and control groups **(H3: within-category intention effects)**. We find evidence for both parts of this hypothesis; collective action planning (CAP) increased intentions to engage in collective action behaviors (β = 0.x, CI = 0.x – 0.x, p < 0.x) but individual action planning (IAP) does not (β = 0.x, CI = 0.x – 0.x, p < 0.x). Likewise, IAP increases intentions to engage in individual actions (β = 0.x, CI = 0.x – 0.x, p < 0.x), but CAP does not (β = 0.x, CI = 0.x – 0.x, p < 0.x) Details from these models are included in **Table 2**.

Figure 3. Intervention effects on action intentions, by action category



Note. Effects on intentions to engage in an action for collective action planning (orange), individual action planning (blue), and control (black). Plot shows marginal effects and 95% CIs for each condition from the mixed effects regression model (H3), averaged per action category (top = collective, bottom = individual).

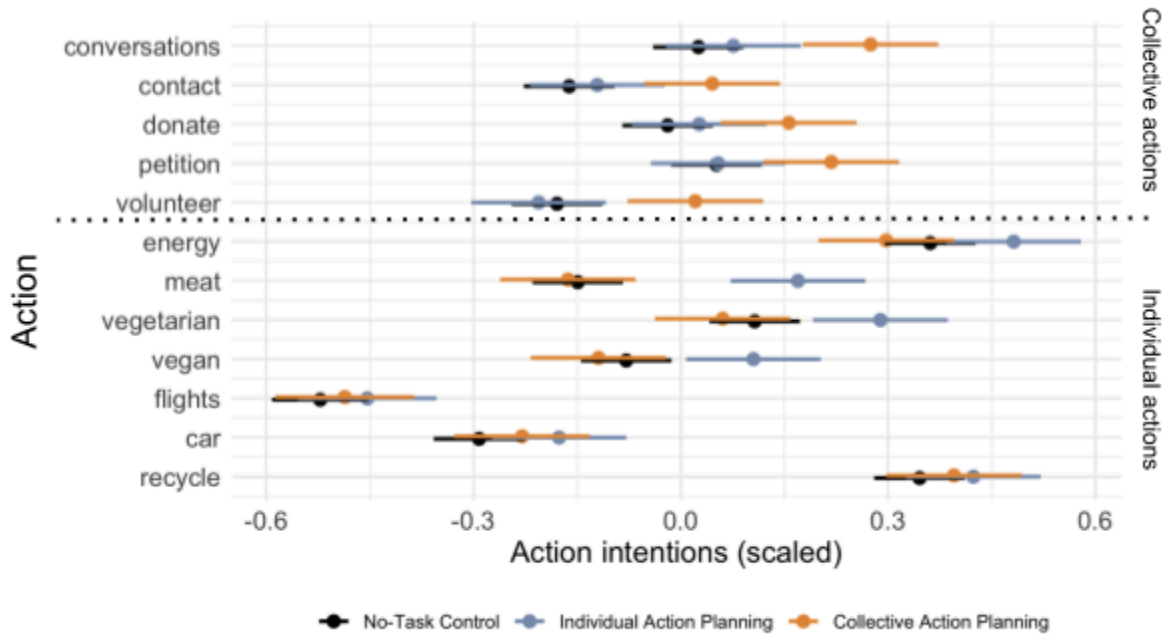
Table 4. Model summaries for within-category intervention effects (H3)

	Individual action intentions (N = 1586)				*Collective action intentions (N = 1586)*			
Predictors	Estimates	CI	Statistic	p	Estimates	CI	Statistic	p
(Intercept)	-0.02	-0.06 – 0.01	-1.38	0.169	0	-0.05 – 0.05	-0.04	0.966
IAP	**0.15**	**0.09 – 0.21**	**4.68**	**<0.001**	0.02	-0.06 – 0.11	0.54	0.591
CAP	0	-0.07 – 0.06	-0.1	0.918	**0.2**	**0.11 – 0.28**	**4.68**	**<0.001**
Current action level	**-0.11**	**-0.12 – -0.09**	**-14.94**	**<0.001**	**0.35**	**0.17 – 0.52**	**3.83**	**<0.001**

Note. Model outputs testing intervention effects per action category (H3). In the left model, we compared the effects of individual action planning (IAP) and collective action planning (CAP) against the control group with *individual* action intentions as the outcome variable. In the right model, we compared the effects of individual action planning (IAP) and collective action planning (CAP) against the control group with *collective* action intentions as the outcome variable. These models both control for current action level and include a random intercept for each participant. For the left model (individual action intentions), Marginal R^2 = 0.022 and Conditional R^2 = 0.145. For the right model (collective action intentions), the Marginal R^2 = 0.022 and Conditional R^2 = 0.145.

In an exploratory follow-up analysis, we also investigated the effect of each intervention on each specific type of action. In this analysis we found results that were fully consistent across every type of collective action planning; in other words, the effect of collective action planning is consistent across each of the collective action behaviors, and no individual action behaviors. Participants who completed the collective action planning task for any of the collective action behaviors reported higher intentions to engage in *every* collective action, and the difference was significant between collective action planning and control conditions, as well as collective and individual action planning conditions. However, the results across individual action planning types were more variable; for individual actions, the effect held in both comparisons only for home energy use, dietary changes (more vegetarian meals, more vegan meals, less red meat), and for individual action planning vs. control alone for car use (driving less). Details are included in **Figure 3**. Estimated marginal means for each action type are included in **Supplementary Materials**.

Figure 4. Intervention effects per action



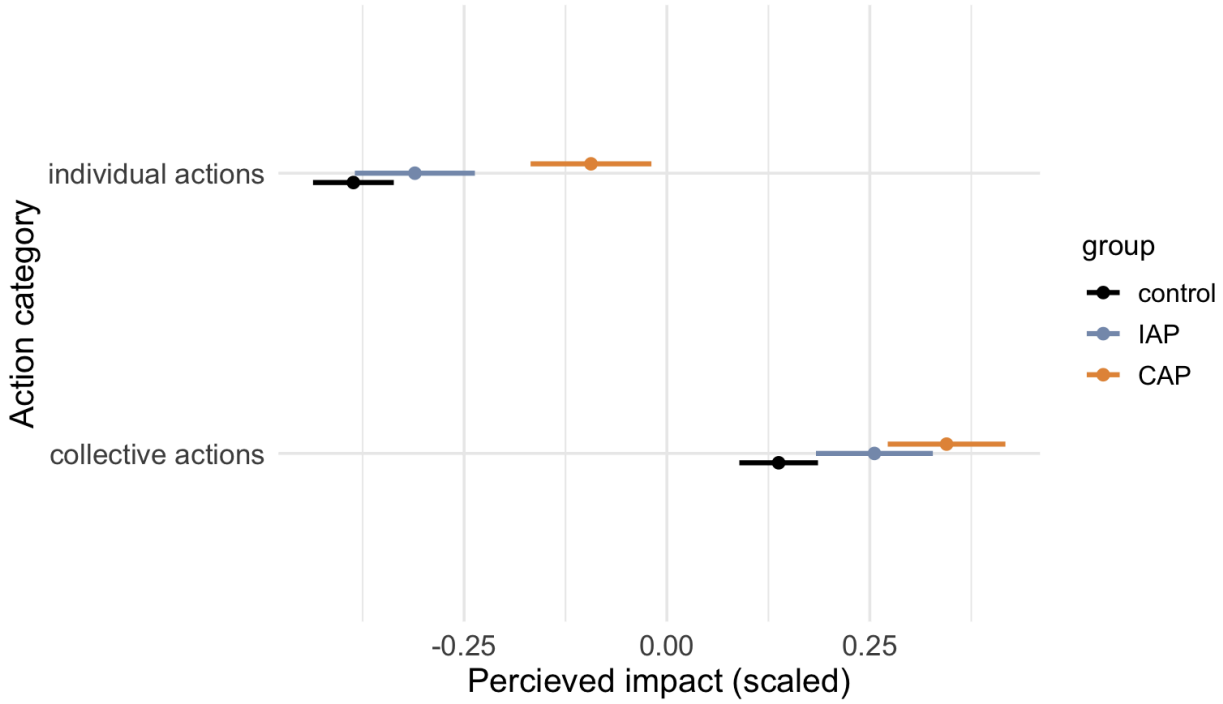
Note. Collective (orange) and individual (blue) action planning intervention effects on intentions per action. Plot shows marginal effects and 95% CIs from the mixed effects regression model (H3) per each action and intervention.

Exploratory analyses: collective vs. individual action planning effects on perceived environmental impact of emergent collective change

In a set of exploratory analyses, we also tested whether action planning interventions increased not just intentions but also the perceived impact of actions—in particular, how impactful each pro-environmental action would be *if many people engaged in it*. Both individual and collective action

planning increased the perceived impact of the specific action participants chose (IAP: β = 0.15, CI = 0.05–0.25, p = 0.004; CAP: β = 0.38, CI = 0.26–0.50, p < 0.001), and these interventions also increased the perceived impact of other pro-environmental action types (effects of intervention on the average across all actions: IAP: β = 0.10, CI = 0.02–0.18, p = 0.019; CAP: β = 0.24, CI = 0.16–0.33, p < 0.001). These results are summarized in **Figure 4**. In the follow-up analysis examining action items separately, we found that CAP yielded significantly greater perceived impact than both IAP and control for each collective action behavior, though overall perceived impact of collective action behaviors was lower than for individual action behaviors. We also found that while CAP increased the perceived impact of every individual action relative to control, IAP did not increase the perceived impact of any collective actions relative to control. For some individual actions, the effect of CAP was significantly higher than the effect of IAP relative to control, namely for eating more vegetarian and vegan meals. The details of this analysis are included in **Supplementary Materials**.

Figure 5. Intervention effects on perceived impact of action, by action category



Note. Collective (orange) and individual (blue) action planning intervention effects on perceived impact of an action if many people did it, averaged per action category (individual, top v. collective, bottom). Plot shows marginal effects from the mixed effects regression model (H3) per each action category and intervention pair.

We also tested several pre-registered secondary hypotheses regarding the effects of our interventions, including climate change related self-efficacy, emotions like hope and determination about climate change, climate change news sharing, and in-study environmental petition signing behavior. We found mixed effects across these secondary outcome measures. Neither intervention (IAP or CAP) had an effect on hope, petition signing, social relevance of climate-related news headlines, negative affective responses to headlines, or overall petition sharing. CAP and IAP both had an effect on

determination. CAP but not IAP had an effect on self-efficacy, self-relevance of climate-related news headlines, overall headline sharing, and positive affective responses to headlines. The details of all pre-registered secondary analyses are included in **Supplementary Materials**.

Discussion

Although the majority of U.S. adults (64%) express worry about climate change, fewer engage in efforts to foster social, systemic, and political changes for a sustainable future (Leiserowitz, 2024). Our findings contribute new evidence that scalable online interventions can effectively increase intentions to engage in both individual and collective climate actions, potentially supporting broader engagement at scale.

In particular, our findings make a novel contribution by showing that a modified mental contrasting with implementation intentions (MCII) intervention can enhance intentions for a target *collective* action, suggesting that psychological interventions may effectively promote collective engagement, not just individual behavior change. This is notable because our intervention included several differences from the standard implementation of the MCII framework: (a) we had participants choose an action from a list as their target for the action planning task, rather than having participants come up with their own goal, (b) we included additional prompts to describe each step of taking the action, (c) we included additional prompts to evoke greater episodic simulation of taking the action, and (d) we asked participants about positive outcomes not only for themselves, but also for their community and the environment. This extends prior work on action planning (Gollwitzer, 1999; Gollwitzer and Sheeran, 2006; Oettingen and Gollwitzer, 2010; Kirk et al., 2013; Mutter et al., 2020; Ort and Fahr, 2022, Loy et al., 2016; Wang et al., 2021, Cross & Sheffield, 2017) to show that both individual and collective action planning interventions increased intentions to engage in the target action.

We also found compelling evidence that our interventions affect not only the specific action targeted in the action planning task, but also other pro-environmental behaviors. This was true for both individual action planning as well as collective action planning interventions, providing evidence that action planning can have generalized effects on broad categories of actions, not only a specific action that is the target of the intervention. This is consistent with prior theory and empirical evidence showing that engaging in a single pro-environmental behavior can increase engagement in other pro-environmental behaviors (Lauren et al., 2016; Lauren et al., 2019; Truelove et al., 2014; Carrico, 2021). However, in a meta-analysis of intervention spillover effects, Geiger et al. (2021) found weak evidence that interventions do not create positive spillover for sustainable behavior intentions. Here, we show that a spillover effect is possible with pro-environmental action intentions; imagining and planning to engage in one pro-environmental action can increase other pro-environmental intentions as well.

Examining within-category effects, we found strong evidence of specificity. Collective action planning increased intentions to engage in collective action behaviors but not in individual action behaviors, while individual action planning increased intentions for individual actions but not collective actions. In prior research, there has been mixed evidence for psychological interventions promoting collective climate action. For example, video interventions (including hypothetical futures resulting from climate action) in Castiglione et al. (2022) did not succeed in boosting climate engagement, possibly because the content was informational and passive rather than generative and participatory, and it did

not involve an action planning component. Similarly, Vlasceanu et al. (2024) tested various psychological interventions across 63 countries, providing cross-cultural evidence for the positive impact of psychological tools on pro-environmental outcomes (e.g., belief in climate change, policy support). However, the study focused less on collective action intentions and engagement, did not include any action planning interventions, and no intervention notably increased climate action, with some even backfiring. Our findings demonstrate new evidence that psychological interventions focusing on future behavior can increase individual and collective climate action intentions.

In exploratory analyses, we found that participants completing action planning interventions also reported a higher perceived impact of pro-environmental behaviors than control participants, but that overall, this effect was stronger for collective versus individual action planning. Furthermore, we found that although collective action planning increased the perceived impact of individual actions, individual action planning did not increase the perceived impact of collective actions. Overall, perceived impact was higher for individual actions than collective actions across all conditions, but action planning, and in particular collective action planning, was effective at increasing the perceived impact of individual and collective pro-environmental behaviors. Importantly, our measure for perceived impact measured *collective* impact—that is, how impactful an action would be if many people did it. This is related to the concept of collective efficacy (Bandura, 2000), i.e., belief in a group's ability to achieve collective goals. Prior work has shown that an individual's collective efficacy (one's belief in a group's ability to achieve collective goals) is a predictor of positive attitudes and behavior regarding both individual and collective climate action (Barth et al., 2016; Hamann & Reese, 2020; Wang, 2017; see Fritsche & Masson, 2021 for a review) and is associated with climate activism (Bonniface and Henley, 2008). Additionally, collective efficacy manipulations increase intentions to engage in pro-environmental transportation (Jugert et al., 2016). Here, we showed that collective action planning can increase the perceived collective impact of both collective and individual pro-environmental behaviors.

We observed a unique benefit of imagining collective action across several dimensions. One possible explanation for our findings is that collaborative action planning may evoke more social cognitive processing or greater anticipation of others' actions in line with a collective goal (Sebanz et al., 2006; Kulis et al., 2022; Kourtis et al., 2019; Tomasello et al., 2005). This could explain the within-category generalized effects of collective action planning, as well as its effects on perceived impact even for individual actions. Since collective action relates to coordinated actions of multiple individuals, collective action planning may require representation of the collective goals and the actions of others, as well as consideration of one's own position within these collective efforts. Our findings show that collective action planning, in particular, can increase participants' sense that people can achieve things together, through emergent as well as coordinated collective change. Future work can test whether collective action planning tasks may evoke greater social cognitive processes and consideration of others' behavior relative to individual action planning.

It is possible that collective action planning also promotes the salience of a collective identity; in past research, greater identification with a group engaging in collective action has been related to greater support for or participation in collective action (van Zomeren et al., 2008; Klandermans & de Weerd, 2000; Kelly & Kelly, 1994; Simon, 1998; Wright & Tropp, 2002). Future research can also address this possible pathway that distinguishes collective action planning from individual action planning, and intervention effects on the salience of collective identification. We also hope to test synergistic effects of

these action planning interventions with other design tools that can promote climate action in future work, such as by translating the task into more interactive activities. In our data, the most common collective action behavior that individuals could see themselves doing more of in the future was having conversations about climate change (see **Supplementary Materials**). There have been a number of resources made available by climate organizations and researchers (e.g., The Nature Conservancy, 2023, *Talk Climate Change*; Ettinger et al., 2023, *Seeding Action*) to facilitate climate change conversations, the prevalence of which is linked to other forms of collective engagement (Ballew et al., 2023; Ettinger et al., 2023). Action planning paired with access to resources for key behaviors of interest could provide even greater effects on both intentions and downstream collective action behavior.

Although this study has several strengths, including a well-powered extension of a theory-driven intervention, it should also be interpreted in the context of limitations that can also serve as inspiration for future research. First, although intentions are well established precursors of behavior change (Fishbein & Ajzen, 1975; Ajzen, 1991; Fishbein & Cappella, 2006), future research that more directly measures behavioral outcomes would strengthen the evidence of intervention effectiveness, and following up with participants in a longitudinal study could allow us to measure potential effects on behavior, as well as the durability of effects on intentions, behavior, and other attitudinal outcomes. Future work can also test more nuanced manipulations of collective vs. individual actions to uncover the mechanistic drivers of the within-category specificity of spillover effects we observed. Additionally, future work can include additional validated measures regarding collective efficacy. Understanding additional barriers that might prevent a person from acting on their intentions and the network of beliefs surrounding each type of action studied here is a key interest for future research. Finally, future work can expand on the application of these interventions to test their generalizability in domains beyond climate change.

Ultimately, our study provides grounds for developing further connections between scholarly research in areas of psychology, environmental behavior, and collective action, as well as with practitioner work providing resources and guides on collective action. We have shown that a simple set of writing prompts as a psychological intervention, which can easily be distributed online in a variety of contexts, can shift both individual and collective action intentions around climate change. We also show that these interventions can increase collective action intentions in a targeted manner, though the task is completed by individuals in isolation. Through future partnerships, this intervention could be adapted into more interactive online tools, pen-and-paper exercises, or workshop formats to improve collective goal setting in a variety of advocacy or institutional settings. Through bridging existing work and developing more nuanced mechanistic understandings of how to encourage action in those who care, we can cultivate a more active public and shape a sustainable future.

Declarations of interest
None

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Supplementary materials

Sampling and stratification details

For this study, we recruited participants who were at least 18 years of age, fluent in English, residing in the United States, had a Prolific approval rating of at least 95%, completed at least 50 Prolific submissions prior to this study, and reported any level of belief in climate change via a single-item pre-screening question, "Do you believe in climate change?" We used quota sampling to recruit evenly by binarized gender (50% men, 50% women; however, 2.8% of our final sample reported an alternative gender identity on our demographic survey), as well as to recruit participants across the adult lifespan (40% younger adults aged 18-35, 40% middle-aged adults aged 36-54, and 20% older adults aged 55-90). Younger and middle-aged adults were oversampled due to the skewed age distribution on Prolific; less than 10% of the platform participants are aged 55-90. Once recruitment slowed to less than 15 participants per day for middle-aged and older adults (17 days after data collection began), we removed quota sampling by age to allow for the full sample size to be collected.

Participants were excluded if they failed both of the attention checks within the survey (n = 1) which required responding as instructed (e.g., "If you are paying attention, select 'somewhat agree' below"). Though we only recruited participants who reported believing in climate change in a screening question, we also validated belief in climate change in our survey. Participants were excluded if they reported denial in anthropogenic climate change either by reporting that climate change is not occurring, attributing climate change to entirely natural causes, or indicating high uncertainty and skepticism about climate change (n = 27).

Other measures included in study

News Headline Task. Participants were shown five news headlines related to climate change, each comprising a title and lede. These headlines were randomly selected from a larger pool of 26 headlines from the New York Times. For each article, participants rated their intention to share it—either broadly on social media or directly with someone they know—on a scale from 0 (strongly disagree) to 100 (strongly agree). Additionally, participants used the same 0-100 scale to evaluate perceived

self-relevance and social relevance, as well as positive and negative affect and their interest in reading the article.

Petitions Task. Participants viewed three climate change petitions, displayed as screenshots of actual petitions from *change.org* with abbreviated text. These were chosen randomly from a set of 10 petitions. For each petition, participants rated their intent to share it—either widely on social media or directly with someone they know—on a scale from 0 to 100 (strongly disagree to strongly agree, respectively). They also rated their intentions of signing each petition. Next, participants were given a link to the full petition on change.org, which they could choose to click for more information and to sign if interested. Link clicks were recorded, and participants self-reported whether they signed the petition.

Self-efficacy regarding climate action (i.e., belief in the power of individuals and society to take action to address climate change) was assessed using four items from the Climate Change Attitude Survey (Christensen & Knezek, 2015), with responses on a 5-point agreement scale (1 = Strongly disagree, 5 = Strongly agree).

Emotions about climate change were also rated on 5-point agreement scales (1 = Strongly disagree, 5 = Strongly agree), including for: anxiety, hopefulness, hopelessness, determination, disengagement, uncertainty, anger, and sadness.

Perceived risk and concern were measured with four items, each using a 5-point agreement scale. **Knowledge** (2 items) and **uncertainty/skepticism** (4 items) were also assessed using 5-point agreement scales (Spence et al., 2012).

For details on other measures collected in this study, please see the larger study report and set of operating procedures [OSF link redacted for review].

Model syntax for pre-registered analyses

H1: target action intention effects:

H1a, CAP: action_intention_s ~ [CAP vs. control]
H1b, IAP: action_intention_s ~ [IAP vs. control]

Where H1a includes observations for only the collective action selected by participants in either CAP or control groups, and H1b includes observations for only the individual action selected by participants in either IAP or control groups,.

H1 preregistered model:
action_intention_s ~ [(IAP or CAP) vs. control] + (1|SID)

H2: general intention effects:

H2: action_intention_s ~ [(IAP or CAP) vs. control] + action_current_s + (1|SID)

H2 exploratory – effects per distinct group:
action_intention_s ~ group + action_current_s + (1|SID)

H3: within-category intention effects:

H3a, CAP: action_intention_s ~ [CAP vs. (IAP or control)]*[action_category_type is collective, reference = individual] + action_current_s + (1|SID)
H3b, IAP: action_intention_s ~ [IAP vs. (CAP or control)]*[action_category_type is collective, reference = individual] + action_current_s + (1|SID)

H3 exploratory – effects per distinct action item:
action_intention_s ~ group*item + action_current_s + (1|SID)

Demographics per group

Table S1 shows demographics per group (CAP, IAP, control). As per χ^2 tests, there were no significant differences between groups based on gender ($\chi^2 = 15.89$, p = 0.31), race ($\chi^2 = 18.15$, p = 0.46), ethnicity ($\chi^2 = 3.26$, p = 0.53), income ($\chi^2 = 18.15$, p = 0.45), education ($\chi^2 = 14.82$, p = 0.39), subjective socioeconomic status ($\chi^2 = 20.85$, p = 0.29), political ideology ($\chi^2 = 7.67$, p = 0.81), or political party affiliation ($\chi^2 = 11.97$, p = 0.62).

Table S1. Demographics per group

Variable	Control *N (%)*	IAP *N (%)*	CAP *N (%)*	Variable	Control *N (%)*	IAP *N (%)*	CAP *N (%)*
Gender				Education level			
Agender, gender fluid, or genderqueer	8 (0.9%)	4 (1.1%)	2 (0.6%)	Did not complete high school	7 (0.9%)	4 (1.1%)	1 (0.3%)
Man	402 (47%)	177 (45%)	172 (45%)	High school graduate (GED)	25 (3.2%)	10 (2.7%)	10 (2.9%)
Gender identity not listed	1 (0.1%)	1 (0.3%)	0 (0%)	Some college (1-4 years, no degree)	173 (22%)	74 (20%)	82 (24%)
Non-binary	15 (1.8%)	7 (1.8%)	7 (1.8%)	Associate's degree (including occupational or academic degrees)	83 (11%)	47 (13%)	26 (7.5%)
Woman	422 (50%)	201 (51%)	198 (52%)	Bachelor's degree (BA, BS, etc)	350 (45%)	156 (42%)	151 (44%)
Age	40 (14)	40 (14)	39 (14)	Master's degree (MA, MS, MENG, MSW, etc)	109 (14%)	61 (17%)	56 (16%)
Race/Ethnicity				Professional school degree (MD, DDC, JD, etc)	17 (2.2%)	10 (2.7%)	7 (2.0%)
American Indian or Alaskan Native	3 (0.4%)	2 (0.5%)	1 (0.3%)	Doctorate degree (PhD, EdD, etc)	14 (1.8%)	6 (1.6%)	13 (3.8%)
Black or African American	110 (13%)	51 (13%)	51 (13%)	Income level			
East Asian	26 (3.1%)	18 (4.6%)	13 (3.4%)	Less than $5,000	13 (1.6%)	10 (2.6%)	9 (2.4%)
Multiple races	43 (5.1%)	24 (6.1%)	33 (8.6%)	$5,000 through $11,999	27 (3.2%)	13 (3.4%)	8 (2.2%)
Native Hawaiian or Other Pacific Islander	1 (0.1%)	1 (0.3%)	1 (0.3%)	$12,000 through $15,999	18 (2.2%)	10 (2.6%)	11 (3.0%)
Racial/ethnic identity not listed	9 (1.1%)	8 (2.0%)	9 (2.4%)	$16,000 through $24,999	54 (6.5%)	11 (2.8%)	16 (4.3%)
South Asian	19 (2.2%)	9 (2.3%)	4 (1.0%)	$25,000 through $34,999	71 (8.5%)	42 (11%)	34 (9.2%)
Southeast Asian	17 (2.0%)	10 (2.5%)	10 (2.6%)	$35,000 through $49,999	115 (14%)	46 (12%)	49 (13%)
White	619 (73%)	267 (68%)	256 (67%)	$50,000 through $74,999	162 (19%)	84 (22%)	79 (21%)
Hispanic/Latinx				$75,000 through $99,999	139 (17%)	65 (17%)	67 (18%)
No	759 (89%)	350 (89%)	332 (87%)	$100,000 through $149,999	136 (16%)	57 (15%)	64 (17%)
Yes	88 (10%)	43 (11%)	47 (12%)	$150,000 and greater	96 (12%)	48 (12%)	32 (8.7%)
Variable	Control *Mean (SD)*	IAP *Mean (SD)*	CAP *Mean (SD)*				
Subjective social status (10-pt scale)	5.00 (3.00)	5.00 (2.00)	5.00 (2.00)				

Key variable distributions per group

For each group (CAP, IAP, and control), Figures S1 and S2 visualize the mean and SEM of current action levels (Figure S1) and future intentions (Figure S2) for each pro-environmental action measured in the study. There is notable variability in group means for current action levels: in the IAP group, current levels of individual actions tend to be higher than control or CAP; and in the CAP group, current levels of collective actions tend to be higher than control or IAP. In our main analyses (H2 and H3) we control for current action levels. However, since people rate both current action levels and future intentions *following* the intervention task, it is possible that these differences in means reflect an intervention effect on not only future intention levels (the outcome variable of our main analyses), but also current action levels. It is unlikely that these differences reflect inherent group differences in the absence of an intervention. Thus, our analyses may give a conservative estimate of intervention effects, since some of the intervention effects may be reflected in reported current action levels. We control for these effects to reduce the impact of group differences on our interpretation of intervention effects on intentions.

Figure S1. Current action levels per group and per action item

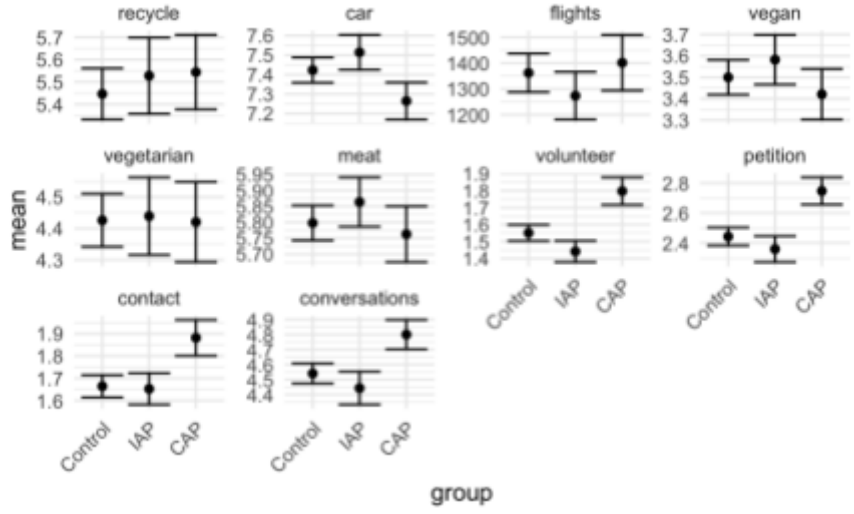
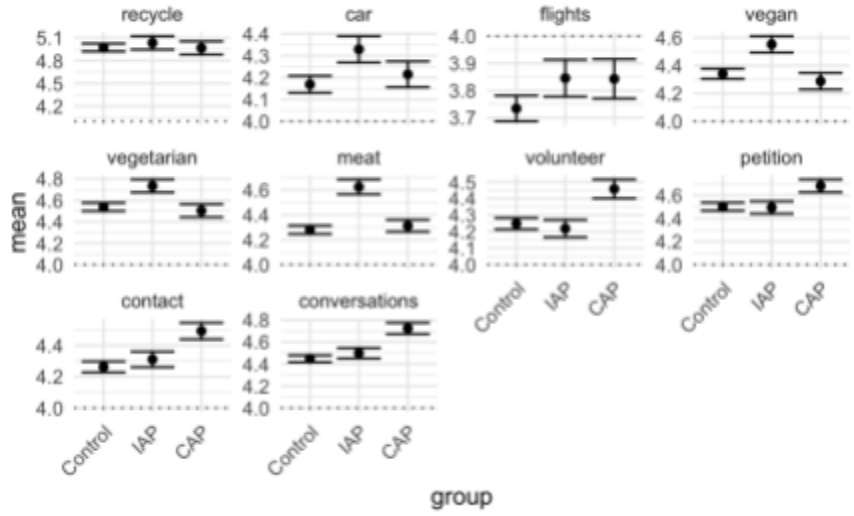


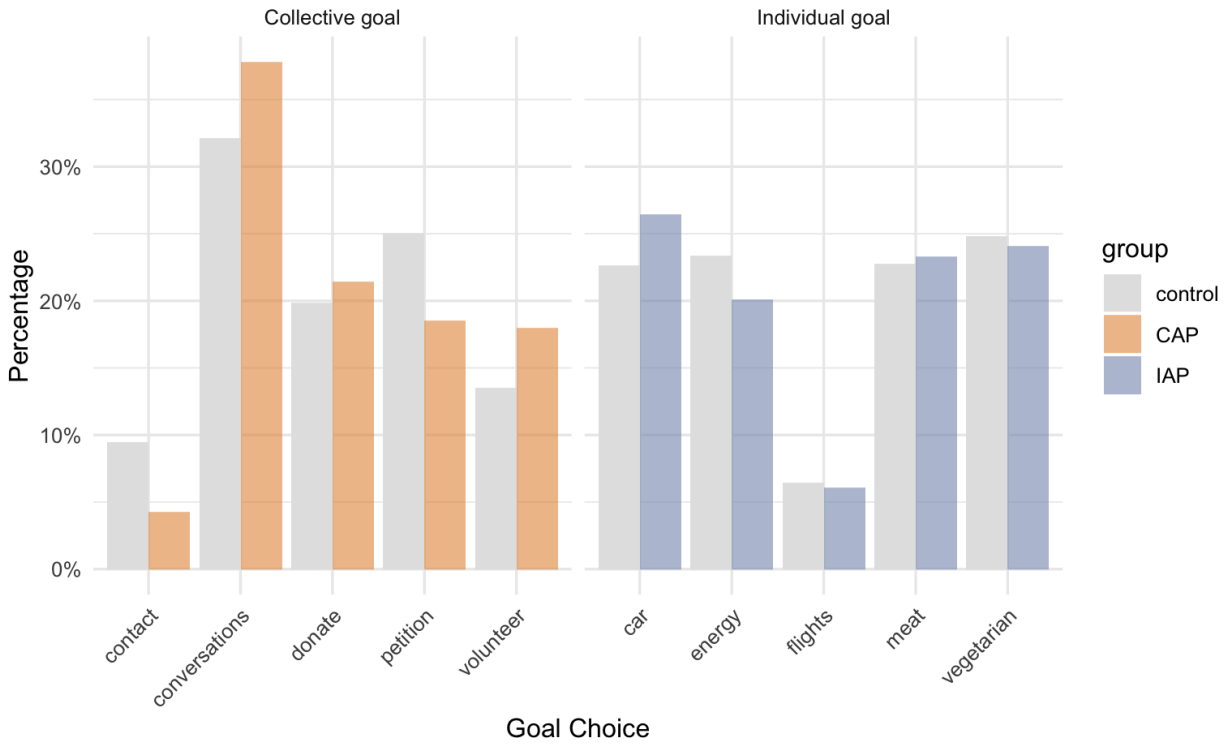
Figure S2. Future intention levels per group and per action item



Note. Current action level = 4. Numbers > 4 indicate doing more of the relevant pro-environmental action (e.g., for "car" this means "driving less"), and numbers < 4 indicate doing less of the relevant pro-environmental action.

Which behaviors did participants choose?

Figure S3. Target actions selected by participants



First, we explore differences across conditions regarding which action participants selected that they could most see themselves starting to do or do more of. Overall, the pattern of choices across options were similar between control and experimental groups. For collective action behaviors, the fewest people selected contacting representatives. The most frequently selected action is having conversations with others about climate change. Participants who selected individual actions chose flying less the least frequently, but choices were fairly distributed across other individual actions. We used a Pearson's chi-squared test to determine whether control and experimental conditions differed for each pair control and individual, and control and collective conditions. There is no significant difference in the actions participants chose between individual action planning and control groups ($\chi^2 = 3.02$, $p = 0.56$), but there was a significant difference between collective action planning and control groups ($\chi^2 = 19.73$, $p = 0.001$). Using adjusted Pearson residuals (collective action planning > control), we find that this difference is significant ($p < 0.05$) for choosing contacting representatives ($r = -3.08$), signing petitions ($r = -2.49$), and volunteering ($r = 1.99$).

Item-wise Estimated Marginal Means for action intentions

Table S2 shows the estimated marginal means (marginal effects) on action intentions, including contrasts for each pair of interventions (IAP, CAP) and control. The model also controls for current action level and includes a random intercept per participant. These results are visualized in Figure 4 in the Results section of the main paper. We found that collective action intentions are significantly higher for participants who completed the CAP task, relative to both IAP and control groups, for every collective action measured. We also found that IAP action intentions are significantly higher for participants who completed the IAP task, relative to both CAP and control groups, for eating more vegetarian and vegan meals, eating less red meat, and paying for clean energy at home, but not recycling, flying less, or driving less.

Table S2. Marginal effects of interventions on action intentions, per action item

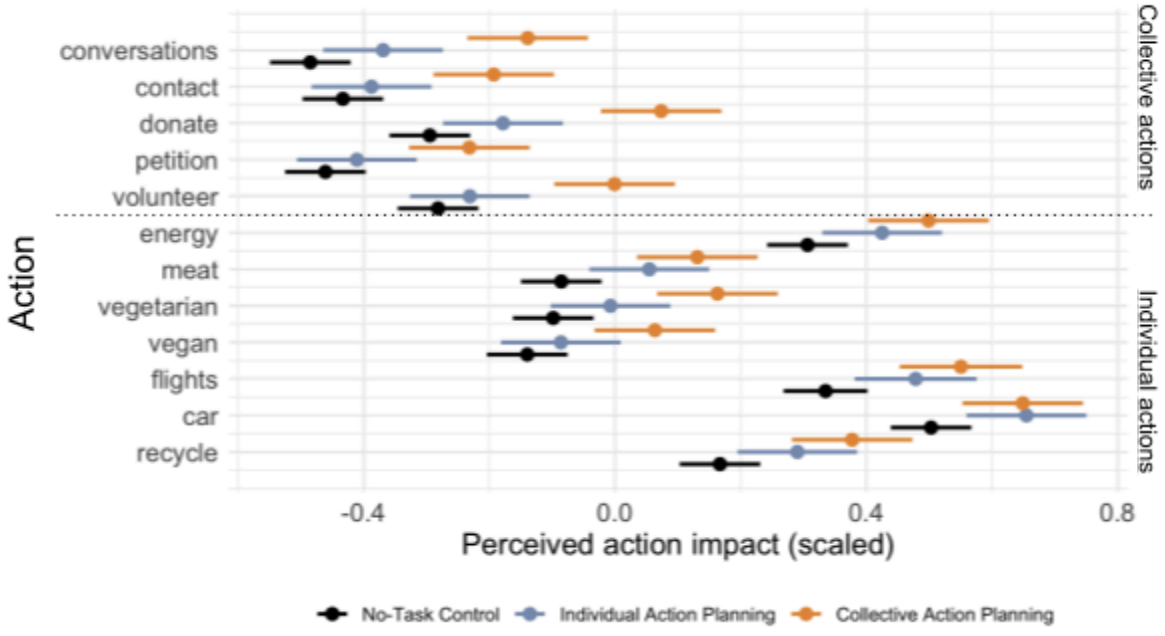
Contrast	Estimate	SE	Z ratio	*p* value	Contrast	Estimate	SE	Z ratio	p value
recycle					***volunteer***				
IAP - control	*0.08*	*0.06*	*1.30*	*0.19*	*IAP - control*	*-0.03*	*0.06*	*-0.44*	*0.66*
CAP - control	*0.05*	*0.06*	*0.83*	*0.41*	*CAP - control*	*0.20*	*0.06*	*3.32*	*< 0.001**
CAP - IAP	*-0.03*	*0.07*	*-0.40*	*0.69*	*CAP - IAP*	*0.23*	*0.07*	*3.21*	*< 0.001**
car					***petition***				
IAP - control	*0.12*	*0.06*	*1.93*	*0.05*	*IAP - control*	*0.00*	*0.06*	*0.04*	*0.97*
CAP - control	*0.06*	*0.06*	*1.03*	*0.3*	*CAP - control*	*0.17*	*0.06*	*2.76*	*0.01**
CAP - IAP	*-0.05*	*0.07*	*-0.76*	*0.45*	*CAP - IAP*	*0.16*	*0.07*	*2.32*	*0.02**
flights					***donate***				
IAP - control	*0.07*	*0.06*	*1.14*	*0.26*	*IAP - control*	*0.05*	*0.06*	*0.76*	*0.45*
CAP - control	*0.04*	*0.06*	*0.59*	*0.55*	*CAP - control*	*0.18*	*0.06*	*2.91*	*< 0.001**
CAP - IAP	*-0.03*	*0.07*	*-0.46*	*0.64*	*CAP - IAP*	*0.13*	*0.07*	*1.84*	*0.07*
vegan					***contact***				
IAP - control	*0.18*	*0.06*	*3.07*	*< 0.001**	*IAP - control*	*0.04*	*0.06*	*0.68*	*0.5*
CAP - control	*-0.04*	*0.06*	*-0.67*	*0.5*	*CAP - control*	*0.21*	*0.06*	*3.44*	*< 0.001**
CAP - IAP	*-0.22*	*0.07*	*-3.18*	*< 0.001**	*CAP - IAP*	*0.17*	*0.07*	*2.36*	*0.02**
vegetarian					***conversations***				
IAP - control	*0.18*	*0.06*	*3.03*	*< 0.001**	*IAP - control*	*0.05*	*0.06*	*0.84*	*0.4*
CAP - control	*-0.05*	*0.06*	*-0.77*	*0.44*	*CAP - control*	*0.25*	*0.06*	*4.14*	*< 0.001**
CAP - IAP	*-0.23*	*0.07*	*-3.24*	*< 0.001**	*CAP - IAP*	*0.20*	*0.07*	*2.81*	*< 0.001**
meat									
IAP - control	*0.32*	*0.06*	*5.32*	*< 0.001**					
CAP - control	*-0.01*	*0.06*	*-0.24*	*0.81*					
CAP - IAP	*-0.33*	*0.07*	*-4.72*	*< 0.001**					
energy									

IAP - control	*0.12*	*0.06*	*2.02*	*0.04**
CAP - control	*-0.06*	*0.06*	*-1.06*	*0.29*
CAP - IAP	*-0.18*	*0.07*	*-2.62*	*0.01**

Perceived impact per item

For exploratory analyses of intervention effects on the perceived impact of actions, we followed the same analytical procedure as our main pre-registered analyses and exploratory post-hoc tests, now using perceived environmental impact as the outcome measure. Again, this measure indicates how impactful a participant believes an action would be if many people did it, offering a proxy for collective efficacy. For our mirror test of the first hypothesis, we found that the both both individual and collective action planning increased the perceived impact of the specific action participants chose (IAP: β = 0.15, CI = 0.05–0.25, p = 0.004; CAP: β = 0.38, CI = 0.26–0.50, p < 0.001), but the perceived impact of the specific action chosen for the intervention task was significantly higher for collective action planning than for individual action planning (t = 3.56, p <0.001). In our mirror test of the second hypothesis, we found that both individual and collective action planning groups reported higher perceived impact across all pro-environmental action types (IAP: β = 0.10, CI = 0.02–0.18, p = 0.019; CAP: β = 0.24, CI = 0.16–0.33, p < 0.001), but again, the Estimated Marginal Mean contrast estimate for CAP>IAP is significant, indicating that this generalized effect of the intervention on perceived impact of actions was greater for CAP than IAP (estimate = 0.142, SE = 0.051, p = 0.013). However, the perceived impact of individual actions (across conditions) is overall higher than the perceived impact of collective actions.

Figure S4. Intervention effects on perceived impact of actions per action item



Note. Collective (orange) and individual (blue) action planning intervention effects on perceived environmental impact, per action. Plot shows marginal effects and 95% CIs from the mixed effects regression model, per each action and intervention.

Item-wise Estimated Marginal Means for perceived environmental impact

Table S3 shows the estimated marginal means (marginal effects) on the perceived impact of actions, including contrasts for each pair of interventions (IAP, CAP) and control. The perceived impact measure reflects how impactful participants believe the action would be if many people did it. The model also controls for current action level and includes a random intercept per participant. We found that the perceived impact of collective actions is significantly higher for participants who completed the CAP task, relative to both IAP and control groups, for every collective action measured. We also found that the perceived impact of individual actions are significantly higher for participants who completed both the IAP and CAP tasks, relative to the control group, for recycling, driving less, flying less, eating less red meat, and paying for clean energy at home. Only CAP was effective at increasing the perceived impact of eating more vegan and vegetarian meals. There were no individual actions where only IAP but not CAP increased the perceived action impact.

Table S3. Marginal effects of interventions on perceived action impact, per action item

Contrast	Estimate	SE	z.ratio	p.value	Contrast	Estimate	SE	z.ratio	p.value
recycle					***volunteer***				
IAP - control	0.12	0.06	2.1	0.04*	*IAP - control*	0.05	0.06	0.86	0.39
CAP - control	0.21	0.06	3.58	< 0.001*	*CAP - control*	0.28	0.06	4.77	< 0.001*
CAP - IAP	0.09	0.07	1.26	0.21	*CAP - IAP*	0.23	0.07	3.34	< 0.001*
car					***petition***				
IAP - control	0.15	0.06	2.59	0.01*	*IAP - control*	0.05	0.06	0.86	0.39
CAP - control	0.15	0.06	2.48	0.01*	*CAP - control*	0.23	0.06	3.89	< 0.001*
CAP - IAP	-0.01	0.07	-0.08	0.93	*CAP - IAP*	0.18	0.07	2.6	0.01*
flights					***donate***				
IAP - control	0.14	0.06	2.45	0.01*	*IAP - control*	0.12	0.06	1.99	0.05
CAP - control	0.22	0.06	3.66	< 0.001*	*CAP - control*	0.37	0.06	6.26	< 0.001*
CAP - IAP	0.07	0.07	1.05	0.3	*CAP - IAP*	0.25	0.07	3.65	< 0.001*
vegan					***contact***				
IAP - control	0.05	0.06	0.91	0.36	*IAP - control*	0.05	0.06	0.78	0.44
CAP - control	0.2	0.06	3.45	< 0.001*	*CAP - control*	0.24	0.06	4.08	< 0.001*
CAP - IAP	0.15	0.07	2.17	0.03*	*CAP - IAP*	0.19	0.07	2.82	< 0.001*
vegetarian					***conversations***				

IAP - control	0.09	0.06	1.56	0.12	*IAP - control*	0.12	0.06	1.98	0.05
CAP - control	0.26	0.06	4.44	< 0.001*	*CAP - control*	0.35	0.06	5.88	< 0.001*
CAP - IAP	0.17	0.07	2.47	0.01*	*CAP - IAP*	0.23	0.07	3.34	< 0.001*
meat									
IAP - control	0.14	0.06	2.39	0.02*					
CAP - control	0.22	0.06	3.68	< 0.001*					
CAP - IAP	0.08	0.07	1.11	0.27					
energy									
IAP - control	0.12	0.06	2.03	0.04*					
CAP - control	0.19	0.06	3.27	< 0.001*					
CAP - IAP	0.07	0.07	1.07	0.28					

Pre-registered secondary analyses

Tables S4 and S5 show the model summaries for secondary analyses. Table S4 shows the person-level secondary analyses, including statistical tests of the effect of our action planning interventions on sense of hope, determination, and efficacy around climate change, as well as intentions to sign and share five petitions on climate-related issues. We found that neither IAP nor CAP had an effect on hope, petition signing, or overall petition sharing. CAP and IAP both had an effect on determination. CAP but not IAP also had an effect on self-efficacy. Looking at the marginal effects o

Table S5 shows secondary analyses for outcome variables related to climate-change related news headlines. We found that neither intervention had an effect on the social relevance of headlines or on negative affective responses to headlines. CAP but not IAP had an effect on the self-relevance of headlines, overall headline sharing, and positive affective responses to headlines.

Table S4. Model summaries for person-level secondary outcome measures

DV	*N*	Marginal R^2 / Conditional R^2	*Variable*	*Estimate*	*CI*	*Statistic*	*p*
Hope	1625	0.002 / 0.001	Intercept	2.54	2.46 – 2.62	61.50	**<0.001**
			Group (IAP)	0.09	-0.05 – 0.24	1.24	0.215
			Group (CAP)	0.11	-0.04 – 0.25	1.47	0.141
Determination	1625	0.006 / 0.005	Intercept	3.07	3.00 – 3.15	81.05	**<0.001**
			Group (IAP)	0.20	0.06 – 0.33	2.90	**0.004**
			Group (CAP)	0.14	0.00 – 0.27	2.02	**0.043**
Efficacy	1625	0.003 / 0.002	Intercept	4.15	4.10 – 4.20	167.74	**<0.001**
			Group (IAP)	0.07	-0.02 – 0.16	1.61	0.107
			Group (CAP)	0.10	0.01 – 0.18	2.17	**0.030**
Petition signing	1624	0.002 / 0.748	Intercept	55.75	52.61 – 58.90	34.71	**<0.001**
			Group (IAP)	-0.16	-4.00 – 3.68	-0.08	0.935
			Group (CAP)	3.34	-0.54 – 7.22	1.69	0.092
Petition sharing	1624	0.007 / 0.701	Intercept	29.58	27.07 – 32.09	23.08	**<0.001**
			Group (IAP)	0.83	-2.95 – 4.61	0.43	0.667
			Group (CAP)	1.94	-1.87 – 5.76	1.00	0.318
			Share type (narrow)	5.86	4.79 – 6.93	10.75	**<0.001**
			IAP * Share type (narrow)	-2.64	-4.54 – -0.74	-2.72	**0.007**
			CAP * Share type (narrow)	0.65	-1.27 – 2.57	0.66	0.508

Note. Estimates are standardized regression coefficients and statistics are t-values.

Table S5. Model summaries for headline-level secondary outcome measures

DV	*N*	Marginal R^2 / Conditional R^2	*Variable*	*Estimate*	*CI*	*Statistic*	*p*
Headline self-relevance	1624	0.001 / 0.585	Intercept	47.64	43.99 – 51.29	25.59	**<0.001**
			Group (IAP)	0.80	-2.26 – 3.86	0.51	0.608
			Group (CAP)	3.15	0.07 – 6.24	2.00	**0.045**
Headline social relevance	1624	0.001 / 0.594	Intercept	48.64	44.98 – 52.30	26.05	**<0.001**
			Group (IAP)	0.49	-2.53 – 3.50	0.32	0.752
			Group (CAP)	2.30	-0.74 – 5.35	1.48	0.138
Headline negative affect	1624	0.001 / 0.634	Intercept	36.56	29.60 – 43.53	10.29	**<0.001**
			Group (IAP)	2.31	-0.26 – 4.89	1.76	0.078
			Group (CAP)	1.18	-1.42 – 3.77	0.89	0.375
Headline positive affect	1624	0.003 / 0.590	Intercept	26.29	19.97 – 32.62	8.15	**<0.001**
			Group (IAP)	0.97	-1.39 – 3.33	0.80	0.421
			Group (CAP)	3.99	1.61 – 6.37	3.28	**0.001**
Headline sharing	1624	0.007 / 0.701	Intercept	27.62	25.11 – 30.14	21.55	**<0.001**
			Group (IAP)	2.32	-0.96 – 5.59	1.39	0.165
			Group (CAP)	3.70	0.40 – 7.01	2.20	**0.028**
			Share type (narrow)	5.80	4.92 – 6.67	12.94	**<0.001**
			IAP * Share type (narrow)	-2.17	-3.73 – -0.61	-2.73	**0.006**
			CAP * Share type (narrow)	0.19	-1.38 – 1.77	0.24	0.810

Note. Estimates are standardized regression coefficients and statistics are t-values.

General intention effects (H2) excluding target action

Table S6 shows the summaries from models of the general (H2) and within-category (H3) intervention effects, excluding the target action for each participant (that is, only non-targeted pro-environmental behaviors). The table also shows post-hoc tests per intervention condition for the H2 analysis. All results were qualitatively similar in regards to the direction of effect, though quantitatively weaker. All results except a significant general effect of CAP relative to the Control condition (across both individual and collective actions) were also similar in regards to statistical significance.

Even excluding the target action, we saw a positive category-specific spillover effect of action planning interventions. That is, we found a significant effect of IAP on individual but not collective action intentions and a significant effect of CAP on collective but not individual action intentions.

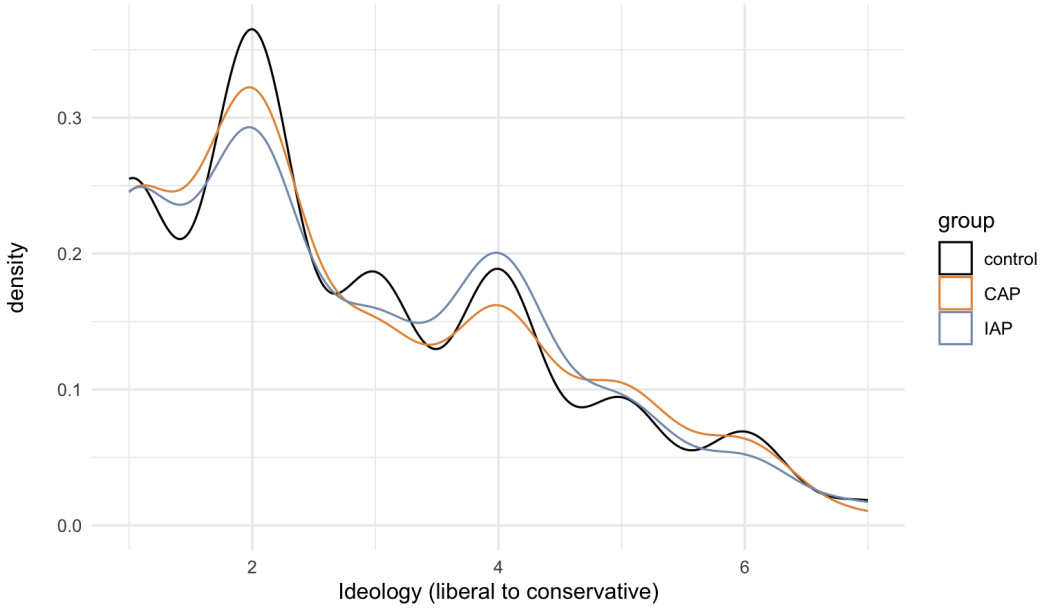
Table S6. Model summaries for H2 and H3 tests, excluding the target action

DV	*N*	Marginal R^2 / Conditional R^2	*Variable*	*Estimate*	*CI*	*Statistic*	*p*
H2: general intentions	1586	0.015 / 0.218	**Intercept**	**-0.07**	**-0.10 – -0.03**	**-3.99**	**<0.001**
			Group (IAP or CAP)	**0.06**	**0.01 – 0.11**	**2.43**	**0.015**
			Current action level	**-0.11**	**-0.12 – -0.10**	**-20.79**	**<0.001**
H2 *post-hoc*: general intentions (IAP v. control)	1213	0.015 / 0.210	**Intercept**	**-0.08**	**-0.11 – -0.04**	**-4.32**	**<0.001**
			IAP	**0.07**	**0.01 – 0.14**	**2.37**	**0.018**
			Current action level	-0.11	-0.12 – -0.09	-14.62	**<0.001**
H2 *post-hoc*: general intentions (CAP v. control)	1208	0.013 / 0.178	**Intercept**	**-0.06**	**-0.09 – -0.03**	**-3.49**	**<0.001**
			CAP	0.05	-0.01 – 0.11	1.62	0.105
			Current action level	**-0.10**	**-0.12 – -0.09**	**-13.63**	**<0.001**
H3: collective action intentions	1586	0.009 / 0.432	Intercept	-0.00	-0.05 – 0.05	-0.04	0.966
			IAP	0.02	-0.06 – 0.11	0.54	0.591
			CAP	**0.20**	**0.11 – 0.28**	**4.68**	**<0.001**
			Current action level	**0.35**	**0.17 – 0.52**	**3.83**	**<0.001**
H3: individual action intentions	1586	0.022 / 0.145	Intercept	-0.02	-0.06 – 0.01	-1.38	0.169
			IAP	**0.15**	**0.09 – 0.21**	**4.68**	**<0.001**
			CAP	-0.00	-0.07 – 0.06	-0.10	0.918
			Current action level	**-0.11**	**-0.12 – -0.09**	**-14.94**	**<0.001**

Note. Estimates are standardized regression coefficients and statistics are t-values.

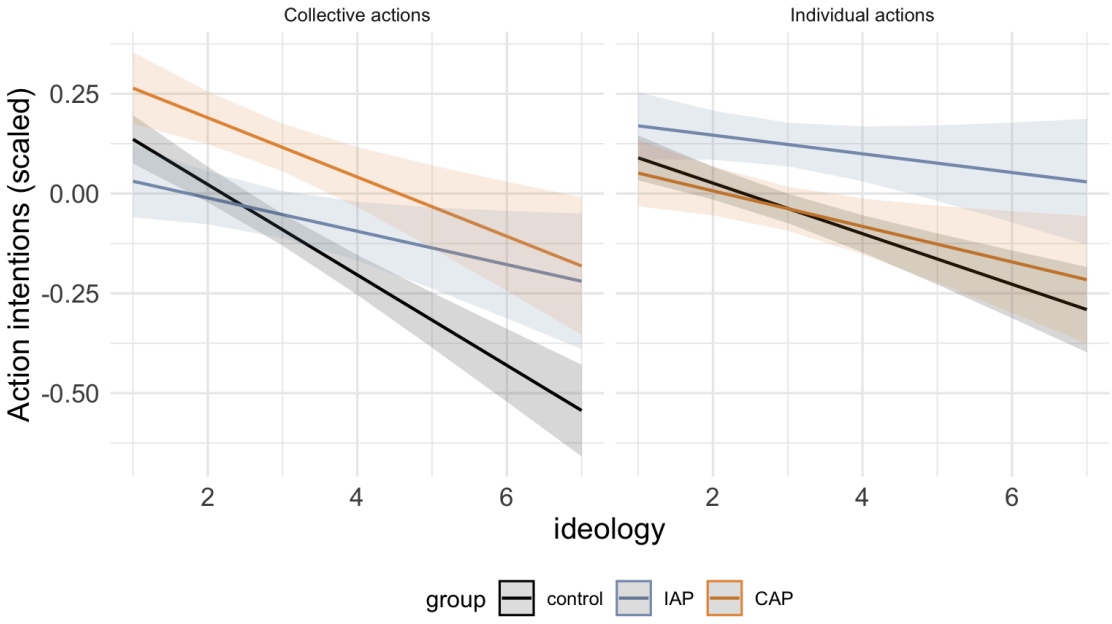
Intervention effects by political ideology

Figure S5. Distribution of ideology per group



Note. Ideology is measured on a 7-point scale from extremely liberal (1) to extremely conservative (7). There was no significant difference in ideology between groups ($\chi 2$ = 7.67, p = 0.81).

Figure S6. Category-specific intervention effects on action intentions by ideology



Note. Ideology is measured on a 7-point scale from extremely liberal (1) to extremely conservative (7).

Table S7. Simple slopes for ideology per condition and action category

Condition	Action category	Ideology trend	SE	Lower 95% CI limit	Upper 95% CI limit
Control	Collective actions	-0.11	0.01	-0.14	-0.09
CAP	Collective actions	-0.07	0.02	-0.11	-0.04
IAP	Collective actions	-0.04	0.02	-0.08	-0.00
Control	Individual actions	-0.06	0.01	-0.09	-0.04
CAP	Individual actions	-0.04	0.02	-0.08	-0.01
IAP	Individual actions	-0.02	0.02	-0.06	0.01

In an exploratory simple slopes analysis, we look at the relationship between ideology and intervention effects. Figure S5 shows the distribution of ideology ratings in each condition. Table S7 shows the simple slope for ideology, per condition and action category, based on a multi-level model testing a three-way interaction between ideology, condition (control, IAP, or CAP), and action category (collective, individual). We found that there is a significant negative effect of ideology on action intentions for both individual action intentions and collective action intentions, but the effect of ideology was attenuated in both intervention conditions relative to the control condition. The relationship between ideology, condition, and action category are also visualized in Figure S6.