

Behavioral Interventions Motivate Action to Address Climate Change

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Abstract

1
2 Mitigating climate change requires mass action. However, individuals may fail to act
3 because they perceive climate change as a threat that is distant or not personally-relevant, or
4 believe their actions are not impactful. To address these psychological barriers, we conducted a
5 large-scale “intervention tournament.” In a sample of 7,624 participants, we systematically tested
6 17 interventions that targeted psychological mechanisms described by three key themes: Self-
7 and Social-Relevance, Future Thinking, and Action Impact. Interventions that emphasized social
8 relevance were the most effective for motivating people to share news articles and petitions
9 about climate change. Interventions that targeted future thinking were the most effective for
10 broadly motivating individual actions (e.g., driving less, eating vegetarian meals) and collective
11 actions (e.g., donating, volunteering) to address climate change. Interventions that emphasized
12 the environmental impact of these actions reliably increased the perceived impact of pro-
13 environmental actions, but did not consistently motivate action. Notably, interventions that
14 targeted two or more mechanisms—such as imagining a future scenario that involved oneself or
15 close others—were most effective. Importantly, our leading interventions were substantially
16 more effective than prevalent existing strategies (e.g., carbon footprint information). Our
17 findings are relevant to theories of behavior change, motivation, and information sharing, with
18 potential applications across domains. Insights from our tournament could be applied to develop
19 scalable online interventions and mass communication campaigns to address climate change.

1 **Significance Statement**

2 Climate change poses an urgent threat to our planet; human behavior is both cause and
3 solution. Although a majority of people believe that climate change is occurring, many fail to
4 take action. We conducted an *intervention tournament*, systematically testing 17 psychological
5 strategies to motivate people to share information about climate change and take action in daily
6 life. Our tournament offers new insights into *which* strategies are most effective and *why*,
7 identifying key mechanisms of action. Our findings are relevant to psychological theories of
8 behavior change, motivation, decision making, learning, and information sharing. Crucially, our
9 leading interventions could be readily scaled to develop accessible and engaging tools for
10 climate change communication, of relevance to communicators, policymakers, and
11 environmental scientists.

12

1 **Behavioral Interventions Motivate Action to Address Climate Change**

2 Climate change poses an urgent threat to our planet and way of life. This human-caused
3 crisis must be addressed by changing human behavior at individual, collective, and institutional
4 levels (1). Although most individuals believe that climate change is occurring—72% in the US
5 (2) and ~85% worldwide (3, 4)—multiple psychological and structural barriers impede climate
6 action (5–8). For instance, individuals may struggle to relate climate change to themselves and
7 people they know, perceive climate change as an abstract future threat, or believe that their
8 actions are not efficacious. To address these barriers, we developed a set of interventions that
9 targeted interrelated psychological mechanisms under three key themes: Self- and Social-
10 Relevance, Future Thinking, and Action Impact. We conducted a large-scale *intervention*
11 *tournament* to systematically test these intervention strategies, aiming to increase **action**
12 **intentions** to engage in pro-environmental behaviors, increase the **perceived impact** of pro-
13 environmental behaviors, and increase intentions to **share information** about climate change.

14 **Psychological Factors Influencing Climate Change Beliefs and Behaviors**

15 Research suggests that people’s perceptions of **self- and social relevance** determine their
16 actions. People may fail to take action because climate change may not seem relevant to
17 themselves or people they know. For example, approximately 40% of Americans report little-to-
18 no impact of climate change in their communities, and do not expect to see much impact in the
19 next thirty years (9, 10). Inaccurate perceptions of social norms can also create the illusion that
20 climate change is not important or relevant to most other people. Such *pluralistic ignorance*
21 regarding climate change has been shown in the U.S. (11) and worldwide (12, 13). These gaps
22 can lead to a “climate of silence”, which exacerbates misperceptions of social norms (14). These

1 perceptions have downstream consequences; individuals who view climate change as a socially-
2 distant problem report lower concern and policy support (15).

3 Recognizing the self- and social-relevance of climate change could motivate people to
4 share information and take action. Converging correlational and causal evidence indicates that
5 when people perceive information as relevant to themselves or close others, they are more likely
6 to value that information and share it with others (16–22). Sharing information about climate
7 change could help address pluralistic ignorance gaps by changing perceived social norms. Social
8 norms have been shown to be a powerful motivator for behavior change across many domains
9 (23, 24), including for climate action (25–31), health (32, 33), and group conflicts (34, 35).
10 Interventions that highlight the self- and social-relevance of climate change or provide
11 information about social norms could therefore address these barriers.

12 A second body of work highlights the promise of **future thinking** interventions for
13 motivating action. Across domains, people tend to demonstrate a *present bias*, overvaluing
14 immediate rewards relative to long-term consequences (36, 37). Such *temporal discounting* may
15 lead individuals to devalue the future threats of climate change. Addressing climate change
16 requires immediate action for long-term gain, much like investing money for retirement instead
17 of spending it (38–40). However, the present bias can be harnessed in service of long-term goals
18 when immediate rewards increase motivation and perseverance (41–43). Imagination exercises
19 can also shift the balance between short-term and long-term priorities, encouraging future-
20 oriented decision making (44, 45). Such imagination exercises have been used to change risk
21 perception and action intentions (46, 47), motivate pro-environmental behaviors (48), and
22 increase prosocial behavior (49, 50). Relatedly, imagining and planning the steps required to
23 achieve a future goal motivates action (51).

1 Thinking about the future could also motivate action by reducing the *psychological*
2 *distance* of climate change. Prior evidence suggests that psychological distance predicts beliefs,
3 concern, action intentions, and policy support (15, 52–54). However, other studies have shown
4 inconsistent effects (55–57). The benefits of reducing psychological distance may be driven by
5 the *social* distance component (i.e., understanding the future impacts of climate change for
6 people like oneself) (15, 54, 58). Thus, future thinking interventions that also appeal to self- and
7 social-relevance may be particularly effective. Supporting this idea, prior studies have shown
8 that thinking about one’s intergenerational legacy reduces psychological distance and motivates
9 climate action (59, 60). Similarly, emphasizing one’s moral responsibility to care for future
10 generations is associated with pro-environmental support (61, 62). Taken together, these studies
11 suggest that imagining future actions and outcomes—for oneself and for future generations—
12 may effectively motivate climate action.

13 A third body of research suggests that interventions should communicate the **impact of**
14 **actions**. Beliefs about one’s ability to achieve particular goals (self-efficacy) and beliefs about
15 the downstream impact of those actions shape intentions (63, 64). Even individuals who are
16 concerned about climate change may fail to take action because they believe that their actions do
17 not matter. Climate change is a complex systems problem (65, 66) that must be addressed with
18 collective action (67). It is difficult to understand or observe the impact of our actions, which
19 may make individuals feel that their contributions are insignificant. Feeling capable of enacting
20 change is associated with action intentions, across domains (64, 68, 69) and for climate change
21 specifically (70–73). Illustrating the cumulative, downstream impact of changing everyday
22 behavior may help people realize that their seemingly small actions do matter, and providing
23 skills coaching can make people feel more confident in their ability to change (74, 75).

1 Another potential barrier is that individuals may be unsure which actions matter most. Beliefs
2 about the impact of pro-environmental behaviors are poorly aligned with recommendations from
3 experts. Individuals favor low-impact actions like recycling over high-impact actions like
4 reducing air travel, and misestimate the energy savings associated with various actions (76, 77).
5 Correcting misconceptions about impact could thus direct effective action.

6 **Identifying and Comparing Effective Interventions**

7 Given the broad spectrum of psychological factors that may motivate behavior change
8 (6), it is essential to systematically test and compare psychological interventions against common
9 benchmarks. Evidence from prior studies pertaining to climate change is mixed and inconclusive,
10 potentially because of differences in task design, outcome measures, construct definitions, study
11 population, and time of year (78). An *intervention tournament* approach (79), in which ideas
12 from multiple sources are tested simultaneously on the same outcome measures, is ideal for
13 overcoming these limitations. The tournament approach enables researchers to assess the *relative*
14 strength of different intervention strategies against a standardized set of outcomes.

15 A recent global study used an intervention tournament to test and compare 11 behavioral
16 interventions for climate change (4). This work laid an important foundation for testing light-
17 touch behavioral interventions, focusing on four key outcomes: beliefs, policy support,
18 information sharing, and action. Results indicated that intervention effects differed considerably
19 across audiences and target behaviors, and effect sizes were small. Notably, some of the most
20 effective interventions for one outcome (e.g., information sharing) had robust backfire effects on
21 other outcomes (e.g., climate action). None of the interventions tested in this tournament
22 increased climate action, and several of the interventions *decreased* action. Overall, this recent
23 tournament identified several promising intervention strategies and investigated cross-cultural

1 differences. These recent findings also highlight a key gap—future studies must test new
2 intervention strategies to motivate climate action, and identify ways to motivate information
3 sharing without producing backfire effects.

4 To address the climate crisis, we urgently need evidence-based, scalable strategies for
5 motivating action. For instance, online interventions could reach broad audiences to motivate
6 individuals to share information, talk to others about climate change, make lifestyle changes,
7 donate, vote, or sign petitions. In addition to developing effective interventions, it is crucial to
8 understand which interventions are ineffective or harmful. For instance, interventions that
9 quantify individuals' carbon footprints are widely promoted by major environmental agencies
10 like the U.S. Environmental Protection Agency (80) and the World Wildlife Fund (81) even
11 though this approach was developed by British Petroleum (82) and there is little empirical
12 evidence of effectiveness (83, 84). Indeed, an argument can be made that overly focusing on
13 individual carbon footprints can reduce perceived urgency of systemic efforts (e.g., policy
14 incentives for decarbonization) (85). Positive, null, and negative intervention effects are all
15 valuable and informative for changing the landscape of climate communication.

16 **Present Studies**

17 To address this pressing societal challenge, we conducted a large-scale intervention
18 tournament to systematically compare the effectiveness of psychological interventions. Our
19 interventions integrate and compare theoretical predictions from across literatures and
20 disciplines. We recruited 7,624 U.S. adults and randomly assigned them to one of 17 intervention
21 conditions or a no-intervention control group in a between-subjects design. To determine the
22 most effective implementation of each intervention strategy, in some cases we tested multiple
23 variations within each “parent” intervention. Interventions targeted one or more psychological

1 mechanisms, addressing the three key themes identified above: *Self- and Social-Relevance*,
2 *Future Thinking*, and *Action Impact*. Some interventions targeted multiple psychological
3 mechanisms and can be described by multiple themes (Figures 1 and 2). For brevity, here we
4 group interventions according to the primary theme for each intervention. Additional information
5 is provided in the *Materials and Methods* section and the SI Appendix.

6 The *Self- and Social-Relevance* theme included interventions that related climate change
7 to oneself and close others. In the **News Comments** interventions, participants wrote brief
8 comments regarding news headlines about climate change, describing why the headlines
9 mattered to them (Self-Relevance condition, n=396), or mattered to people they knew (Social-
10 Relevance condition, n=392). In the **Social Norm Information** interventions, participants
11 viewed statistics about normative attitudes (e.g., belief in climate change, policy support,
12 willingness to make lifestyle changes), either as an interactive quiz with feedback (Norm Quiz
13 condition, n=426), or as descriptive statements (Norm Text condition, N=428). In the **Moral**
14 **Values** intervention (N=420), participants identified their most important moral value from a list,
15 then completed a writing exercise and read a message that related their chosen moral value to
16 climate change.

17 The *Future Thinking* theme included interventions that illustrate potential long-term
18 consequences of climate change and pro-environmental behaviors. In the **Guided Imagination**
19 interventions, participants completed a structured imagination and writing exercise. Participants
20 imagined one of four scenarios; we varied whether participants imagined themselves or a
21 fictional character experiencing a negative future that could result from failure to address climate
22 change (Prevention-Self condition, n=380; Prevention-Other condition, n=374) or a positive
23 future that could result from climate action (Promotion-Self condition, n=373; Promotion-Other

1 condition, n=374). In the **Action Planning** interventions, participants chose a personal climate
2 action goal and developed a detailed plan to achieve it, imagining the steps involved, potential
3 obstacles, and outcomes. Participants selected a target action from a list of individual actions
4 (Individual Action Planning condition, n=393), such as flying less or driving less, or a list of
5 collective actions (Collective Action Planning condition, n=382), such as donating to or
6 volunteering for climate-related organizations. In the **Letter to Future Generation** intervention
7 (N=391), participants wrote a letter to a socially-close child as if the recipient would read this
8 letter in the future, as an adult. In the letter, participants described their aspirations and efforts to
9 ensure that the child would inherit a habitable planet.

10 The *Action Impact* theme included interventions that emphasized the potential benefits of
11 pro-environmental behaviors, for the planet or for oneself. In the **Impact Information**
12 interventions, participants learned about the environmental impact (estimated reduction of
13 greenhouse gas emissions) of actions that individuals could take to mitigate climate change,
14 either by completing a quiz with feedback (Impact Quiz condition, n=416) or reading descriptive
15 statements (Impact Text condition, n=418). In the **Carbon Footprint** interventions, participants
16 either received general information about how lifestyle changes can reduce one's carbon
17 footprint (General Carbon Footprint condition, n=428), or completed a lifestyle survey and
18 received personalized feedback about how various actions would reduce their carbon footprints
19 (Personalized Carbon Footprint condition, n=413). In the **Personal Benefits** intervention
20 (n=370), participants brainstormed short-term *personal* benefits (e.g., improving health,
21 happiness, relationships, or finances) that could arise from engaging in pro-environmental
22 behaviors over the next six months.

23

1 ***Outcome Measures***

2 We focused on three primary outcome measures: *Intentions to take action* to mitigate
3 climate change, *perceived impact* of climate action, and *intentions to share information* about
4 climate change.

5 In the Climate Action task, participants answered questions about seven individual
6 actions (e.g., eating vegan meals, paying for renewable energy at home) and five collective
7 actions (e.g., volunteering, donating) related to climate change. Importantly, these target
8 behaviors were both feasible for individuals (as identified in a pilot study) and impactful for
9 addressing climate change (in terms of estimated reduction of greenhouse gas emissions) (86).
10 For each action, participants reported their current frequency of engaging in the action and their
11 **intentions to engage in the action** more or less in the future (1=*a lot less*, 7=*a lot more*).
12 Participants also rated the **perceived impact** of each action (i.e., collective efficacy beliefs),
13 estimating the beneficial environmental impact if many people engaged in a particular action
14 (1=*no impact*, 7=*very large impact*).

15 In separate tasks, participants viewed five news headlines about climate change (sourced
16 from *The New York Times*) and three petitions about climate change (sourced from *change.org*).
17 For each headline or petition, participants used a scale ranging from 0 (*strongly disagree*) to 100
18 (*strongly agree*) to rate their **intentions to share the information** broadly on social media and
19 directly with people they knew.

20 We also included other measures that were intended to investigate psychological
21 mechanisms of action and other intervention effects. These secondary measures included self-
22 efficacy beliefs, emotions related to climate change, psychological distance of climate change,

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- 1 perceived risk of climate change, perceived self- and social-relevance of climate information,
- 2 and intentions to sign petitions.
- 3

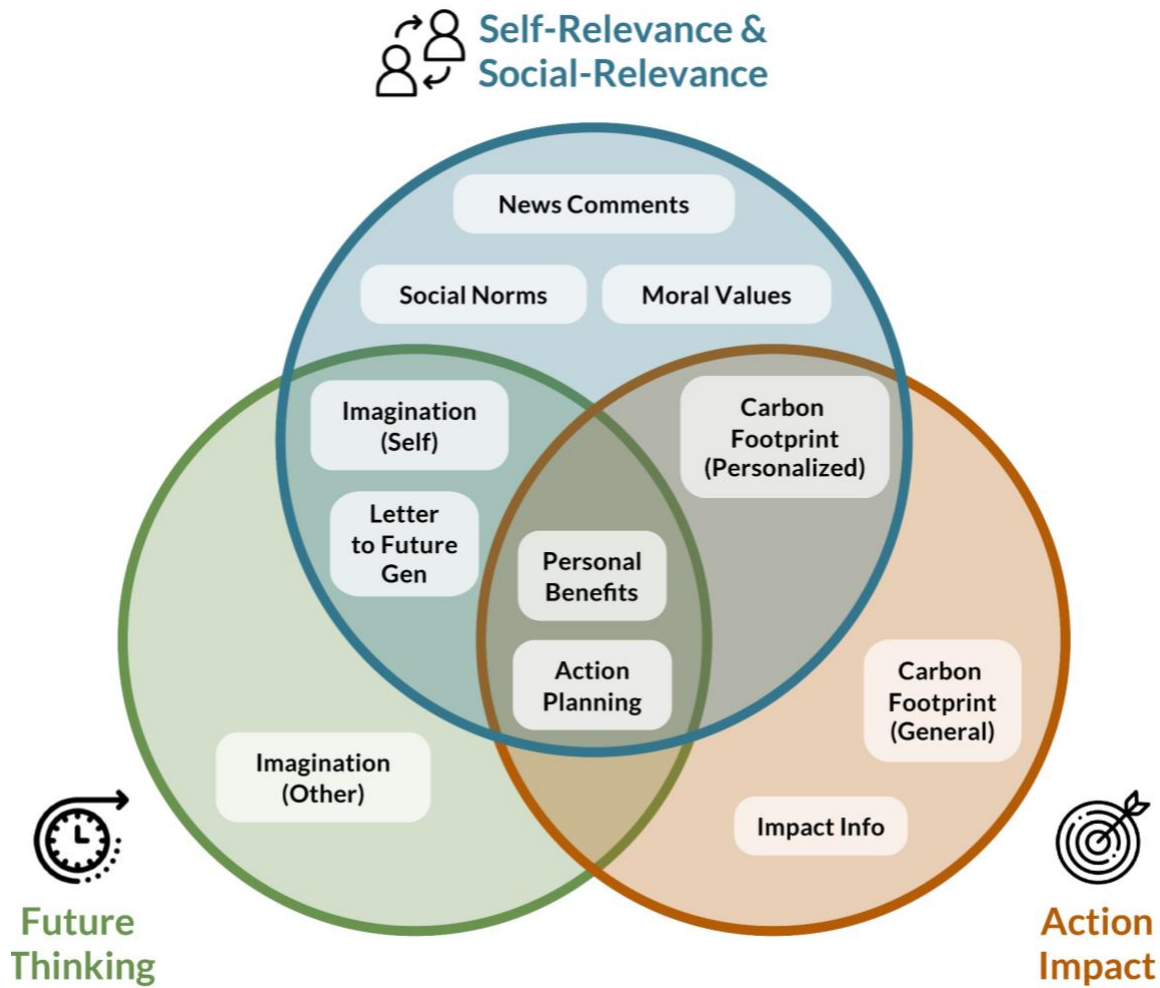


Figure 1. Overview of psychological mechanisms tested in the intervention tournament, organized into three key themes: Self- and Social-Relevance (top), Future Thinking (left), and Action Impact (right). Some interventions, indicated in overlapping portions of the theme circles, leveraged multiple psychological mechanisms.

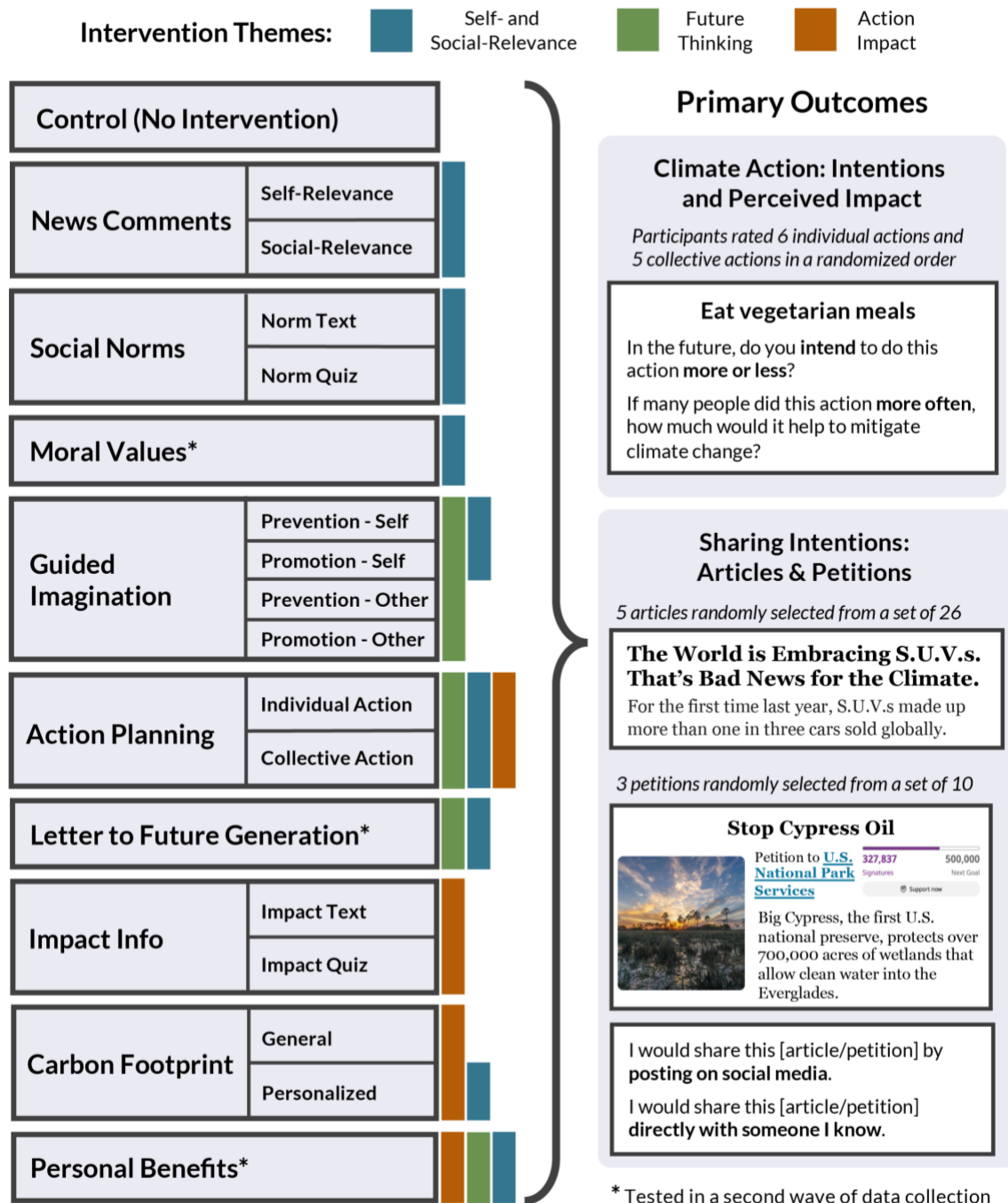


Figure 2. Overview of the intervention tournament. The left panel lists all interventions tested in Phase 1; for some intervention strategies, we tested multiple variations. Where applicable, these sub-groups are labeled in smaller boxes to the right of each parent intervention label. Interventions targeted different psychological mechanisms, indicated here with three color-coded themes: Self- and Social-Relevance, Future Thinking, and Action Impact. Some interventions targeted multiple mechanisms (see Figure 1), marked with multiple colored bars to the right of each intervention box. For multi-theme interventions, the leftmost box indicates the primary

theme. The Control group did not complete any intervention task, and proceeded directly to completing the outcome measures after providing consent. Participants were randomly assigned to a group in a between-subjects design. The right panel illustrates the primary outcome measures: ratings of future intentions and perceived impact regarding pro-environmental individual and collective actions related to climate change, and intentions to share news headlines and petitions about climate change. All participants completed the same set of outcome measures. In addition to the primary outcomes illustrated here, participants also completed a battery of secondary outcome measures, described in detail in the SI Appendix. * denotes intervention conditions that were tested in a second wave of data collection; all interventions were compared with the same control group for consistency.

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Results

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For all analyses, we used Bayesian linear regression models to compare each outcome

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measure across conditions (17 intervention groups and the Control group). Measures with

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multiple observations per participant (e.g., action intentions, perceived impact, sharing

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intentions) were assessed with mixed-effects models. The model predicting action intentions also

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included a covariate to account for current frequency of engaging in each behavior. We

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compared point estimates (median of posterior distribution) for each intervention condition with

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the Control condition; we consider an intervention effect significantly different from the Control

11

group if the lower bound of the 95% credible interval is greater than the Control group point

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estimate. Further information about statistical analysis is provided in the Methods.

13

Primary Outcome Measures

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Results for all primary outcome measures are summarized in Table 1.

15

Pro-Environmental Behaviors: Intentions and Perceived Impact

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Several interventions effectively increased action intentions, particularly the interventions

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that targeted multiple psychological mechanisms (Figure 3, left; Table S2). The Prevention-Self

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variant of the Guided Imagination intervention had the strongest effect on action intentions,

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closely followed by the Letter to Future Generation intervention. Several other interventions also

1 increased action intentions (in decreasing order of effect size): Action Planning (Individual),
2 Personal Benefits, Guided Imagination (Prevention-Other), and Action Planning (Collective).
3 Overall, results support the idea that imagining future actions and outcomes is an effective
4 strategy for motivating climate action, particularly when combined with appeals to self- and
5 social-relevance. We also explored intentions across categories of actions (e.g., diet-related,
6 transit-related, collective actions); results by category are reported in Table S3. Notably, the two
7 leading interventions—Guided Imagination (Prevention-Self) and Letter to Future Generation—
8 broadly increased intentions to engage in both collective and individual actions.

9 Next, we investigated whether the interventions increased the perceived impact of pro-
10 environmental behaviors. Participants rated perceived impact for each action after reporting
11 current behavior and future intentions (see Methods, Climate Action Task). Most of the
12 interventions (13 of 17 conditions) increased perceived impact relative to the Control group
13 (Figure 3, right; Table S4). The most effective conditions were the Letter to Future Generation,
14 Personal Benefits, Moral Values, and Impact Information (Quiz) interventions. We also explored
15 whether perceived impact differed across action categories (e.g., diet-related, transit-related,
16 collective actions); results are reported in Table S5.

17 Notably, all of the interventions in the Action Impact theme increased perceived impact,
18 as expected given that these interventions emphasized impact (for the environment or for
19 oneself). However, several interventions belonging to other themes were also effective,
20 suggesting that directly providing information about impact was not necessary to increase
21 perceived impact.

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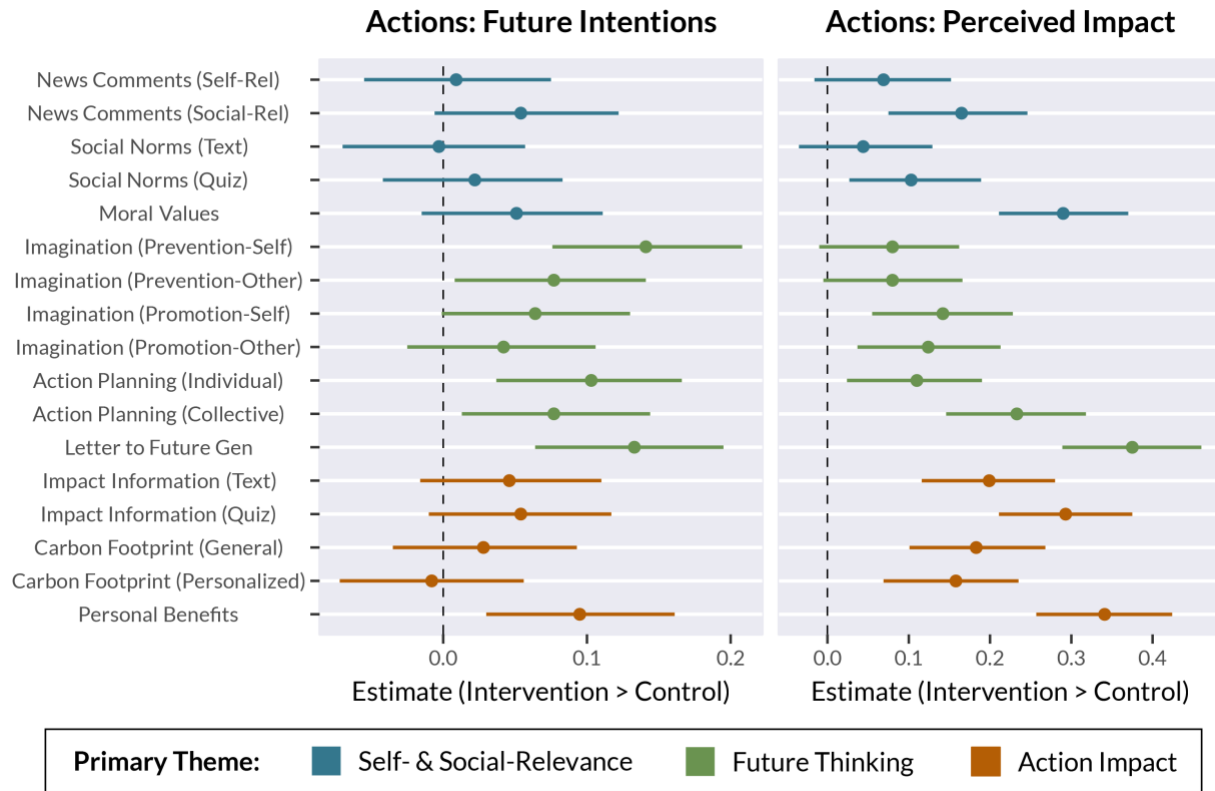


Figure 3. Results from the Climate Action Task, including action intentions (left) and perceived impact of pro-environmental behaviors (right). Results shown are estimates derived from Bayesian mixed-effects regression models. Point estimates indicate the treatment effect for each intervention condition (Intervention - Control, comparing the median values from each posterior distribution). Error bars mark 95% credible intervals surrounding the point estimates. Dependent variables were z-scored to provide standardized effect sizes. Dotted lines marks zero (no effect; no difference from Control group). Points are color-coded to reflect the three intervention themes: Self- and Social-Relevance, Future Thinking, and Action Impact. Note that some interventions can be described by more than one theme (see Figures 1 and 2); colors here indicate a primary theme for each intervention.

1 *Intentions to Share Information about Climate Change*

2 Results for all information sharing outcomes are visualized in Figure 3 and reported in
3 Table S6 (articles) and Table S7 (petitions). We first investigated intentions to share news
4 articles about climate change broadly on social media (“broadcast” sharing). Broadcast sharing
5 intentions for news articles were greatest in the two conditions within the News Comments
6 intervention (Social-Relevance and Self-Relevance). Several other interventions also increased
7 broadcast sharing intentions relative to the Control group (in decreasing order of effect size): the
8 Letter to Future Generation, Moral Values, Personal Benefits, Impact Quiz, and Collective
9 Action Planning conditions all had small effects on broadcast sharing intentions.

10 Next, we repeated the analysis described above to investigate intentions to share news
11 articles directly with another person (“narrowcast” sharing). Results were very similar to the
12 analysis of broadcast sharing intentions. Narrowcast sharing intentions were greatest in the
13 Social-Relevance variant of the News Comments intervention, followed by the Self-Relevance
14 variant of the same intervention and the Letter to Future Generation intervention. The Moral
15 Values, Personal Benefits, and Collective Action Planning conditions all had smaller effects on
16 narrowcast sharing intentions.

17 Using the same approach as for the analysis of intentions to share news articles, we then
18 investigated broadcast and narrowcast sharing intentions regarding *petitions* about climate
19 change. Broadcast sharing intentions for petitions were greatest in the Letter to Future
20 Generation intervention and the Social-Relevance variant of the News Comments Intervention,
21 followed by the Self-Relevance variant. The Personal Benefits and Impact Quiz conditions also
22 slightly increased broadcast sharing intentions relative to the Control group.

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1 In a separate model, we assessed narrowcast sharing intentions for petitions. The Letter to
2 Future Generation intervention had the greatest effect on narrowcast sharing intentions, followed
3 by the Social-Relevance variant of the News Comments intervention, the Personal Benefits
4 intervention, and the Self-Relevance variant of the News Comments intervention.

5 Overall, we found that the News Comments interventions (particularly the Social-
6 Relevance variant) and the Letter to Future Generation intervention were broadly effective at
7 increasing intentions to share both news articles and petitions about climate change (Figure 3,
8 main text). Although other interventions also had small effects on sharing intentions, these
9 conditions were consistently among the most effective.

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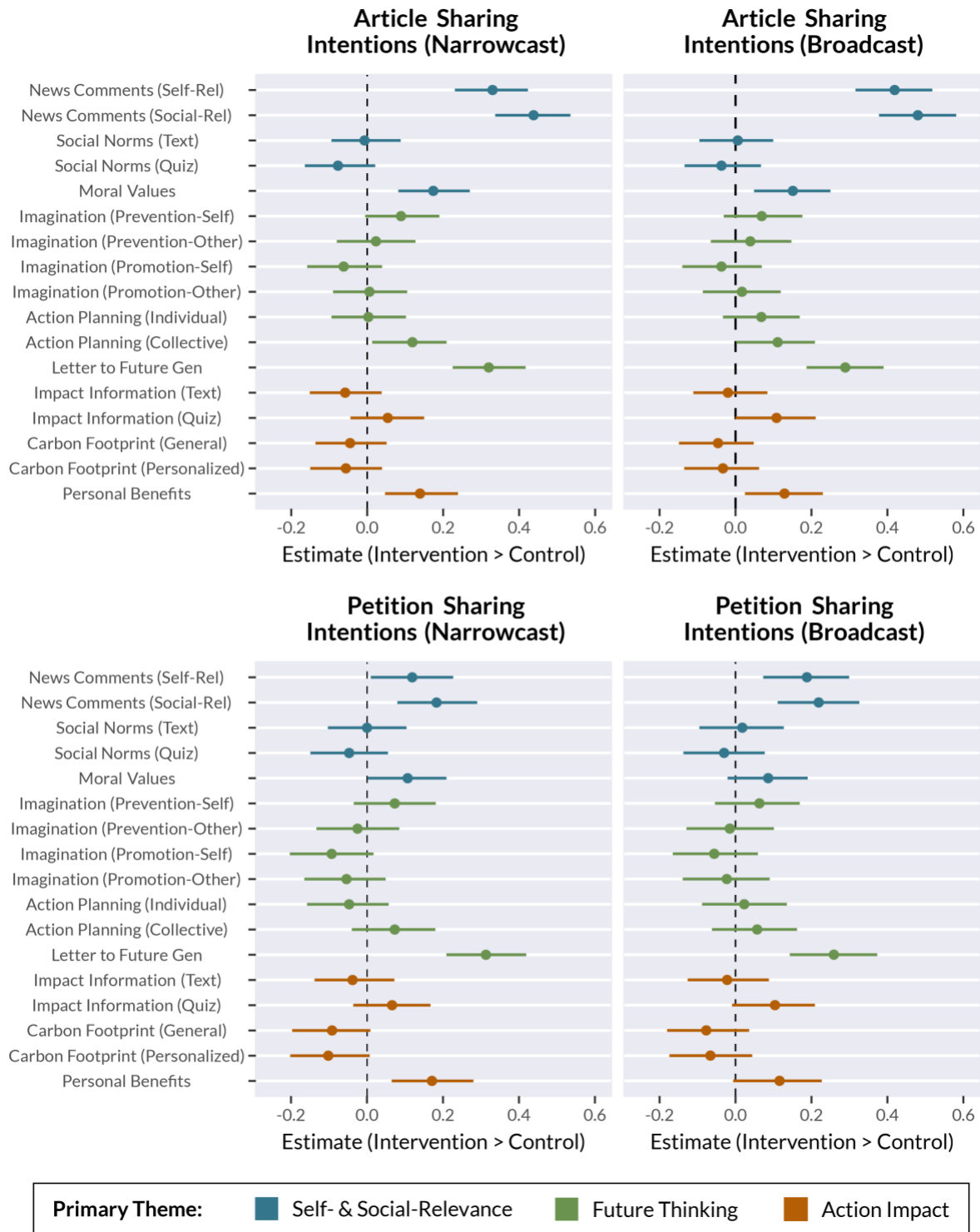


Figure 4. Results for intentions to share news articles (top) and petitions (bottom) about climate change, either directly with a known other (“narrowcast” sharing) or broadly on social media (“broadcast” sharing). Results shown are estimates derived from Bayesian mixed-effects regression models. Point estimates indicate the treatment effect for each intervention condition (Intervention - Control, comparing the median values from each posterior distribution). Error

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bars mark 95% credible intervals surrounding the point estimates. Dependent variables were z-scored to provide standardized effect sizes. Dotted lines marks zero (no effect; no difference from Control group). Points are color-coded to reflect the three intervention themes: Self- and Social-Relevance, Future Thinking, and Action Impact. Note that some interventions can be described by more than one theme (see Figures 1 and 2); colors here indicate the primary theme for each intervention.

Intervention Condition	Action Intentions	Perceived Impact	News Sharing	Petition Sharing
News Comments (Self-Rel)			+	+
News Comments (Social-Rel)		+	+	+
Social Norms (Text)				
Social Norms (Quiz)		+		
Moral Values		+	+	
Imagination (Prevention-Self)	+			
Imagination (Prevention-Other)	+			
Imagination (Promotion-Self)		+		
Imagination (Promotion-Other)		+		
Action Planning (Individual)	+	+		
Action Planning (Collective)	+	+	+	
Letter to Future Gen	+	+	+	+
Impact Information (Text)		+		
Impact Information (Quiz)		+		
Carbon Footprint (General)		+		
Carbon Footprint (Personalized)		+		
Personal Benefits	+	+	+	+

Table 1. Summary table of results for primary outcome measures. + indicates a significant intervention effect (greater than Control group). Shaded cells identify the intervention with the strongest effect for each outcome measures.

1 **Secondary Outcome Measures**

2 Results for all secondary outcome measures are summarized in Table S8.

3 *Perceived Self- and Social-Relevance of News Headlines*

4 During the News Headlines task, all participants rated the extent to which they perceived
5 that a given news headline was relevant to themselves or relevant to people they know. In separate
6 models, we compared self- and social-relevance ratings across conditions (Table S9). As
7 expected, the two variants of the News Comments intervention (in which participants wrote
8 comments about why these news headlines were relevant to themselves or others) had the
9 strongest effects, substantially increasing perceived self-relevance and social-relevance relative
10 to the Control group. The Letter to Future Generation intervention also moderately increased
11 perceived self- and social-relevance. Interestingly, the Quiz condition within the Social Norms
12 intervention had a backfire effect, decreasing both self- and social-relevance relative to the
13 Control group.

14 Overall, these findings are consistent with prior evidence that perceived self- and social-
15 relevance is a key mechanism that accounts for intentions to share information (16). The two
16 News Comments interventions and the Letter to Future Generation intervention, the most
17 effective interventions for motivating individuals to share news articles and petitions about
18 climate change, all increased the perceived self-relevance and social-relevance of information
19 about climate change. Furthermore, these findings suggest that relating climate change to
20 specific *close others* can increase perceived self- and social-relevance of climate change
21 information, but learning about *general normative attitudes* may have the opposite effect.

22

23

1 *Psychological Distance of Climate Change*

2 Next, we investigated psychological distance associated with climate change (i.e., how
3 remote the effects of climate change feel). We were interested in whether the interventions
4 would decrease the psychological distance of climate change. The psychological distance
5 measure included three subscales: temporal distance (i.e., when we will see widespread effects of
6 climate change), geographic distance (i.e., whether climate change will impact your local area),
7 and social distance (i.e., whether climate change will impact you and people like you). We
8 examined each of these subscales separately, using Bayesian linear regression to compare each
9 intervention condition with the Control group.

10 Results for the three psychological distance subscales are reported in Table S10. Only the
11 Personal Benefits decreased perceived temporal distance relative to the Control group. None of
12 the interventions influenced geographic distance. The Social Norms (Quiz) and Moral Values
13 interventions, both within the Self- and Social-Relevance theme, decreased social distance
14 relative to the Control group. Overall, we saw limited effects on psychological distance,
15 suggesting that the benefits of the leading interventions were not driven by reducing the
16 perceived distance of climate change. These null results add to growing evidence that the
17 psychological distance may have previously been overestimated, and reducing distance does not
18 always motivate action.

19 *Self-Efficacy, Perceived Risk, and Emotions Related to Climate Change*

20 We calculated composite scores from a subset of four items related to self-efficacy
21 selected from the Climate Change Attitude Survey (87). These survey items assessed belief in
22 our ability (as individuals and as a society) to take action to mitigate climate change. Using
23 Bayesian linear regression, we compared self-efficacy scores in each intervention group with the

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1 Control group. In descending order of effectiveness, the Personal Benefits, Moral Values, Letter
2 to Future Generation, Guided Imagination (Promotion-Other), Impact Information (Quiz), Action
3 Planning (Collective), and News Comments (Social-Relevance) interventions all increased self-
4 efficacy relative to the Control group (Table S11).

5 To assess perceived risk, we calculated composite scores from a four-item scale
6 measuring concern and perceived risk related to climate change (see SI Appendix). The two
7 prevention-focused variants of the Guided Imagination intervention (Prevention-Self and
8 Prevention-Other) both increased concern and perceived risk relative to the Control group (Table
9 S12). No interventions decreased concern and perceived risk.

10 To assess broader emotions related to climate change, we compared ratings of feelings of
11 anger, anxiety, determination, disengagement, hope, hopelessness, sadness, and uncertainty
12 related to climate change. In brief, several interventions modulated emotions. The Letter to
13 Future Generation condition increased anger, hope, and determination, and also decreased
14 disengagement. The Prevention variants of the Guided Imagination intervention increased anger,
15 anxiety, and sadness. In contrast, the Promotion variants of the Guided Imagination intervention
16 increased hope and determination, and decreased hopelessness. The Carbon Footprint
17 (Personalized) intervention decreased anxiety and uncertainty. The Moral Values intervention
18 increased hope and determination, and decreased anxiety. Several other interventions also
19 increased determination, including the Action Planning, Moral Values, and News Comments
20 (Social-Relevance) conditions. Importantly, none of the interventions decreased hope or
21 increased hopelessness or disengagement. Detailed results are reported in the SI Appendix
22 (Table S13, *Emotions Related to Climate Change*).

23

1 ***Petition Signing Intentions***

2 In the Petitions task, participants viewed three petitions about climate change, adapted
3 from real online petitions. We collected three measures related to petition signing, described
4 below; results are reported in Table S14. Participants first rated their willingness to sign each
5 petition. Using Bayesian linear mixed-effects regression (including random intercepts for
6 participants and stimuli), we compared signing intentions among conditions. The Letter to Future
7 Generation and Personal Benefits interventions increased petition signing intentions relative to
8 the Control group. No interventions decreased signing intentions. We also provided participants
9 with a link to the petition, which they could optionally click to learn more and sign the petition if
10 desired. We tracked clicks on the petition links, but due to a technical error, only partial data
11 were saved. Exploratory analyses with the link click data are reported in Table S14.

12 ***Insights from Secondary Outcomes***

13 Overall, results from our secondary outcome measures offer insights into the potential
14 mechanisms underlying the most effective interventions we identified. Taken together, these
15 results suggest that the interventions that motivated information sharing worked by increasing
16 the perceived self- and social-relevance of climate change information. Conversely, insights
17 from secondary measures suggest multiple distinct routes to motivating climate action. The
18 leading interventions that increased action intentions may work by activating one or more
19 mechanisms, including eliciting anger, increasing the perceived risk of climate change, and
20 increasing self-efficacy.

1 **Discussion**

2 Addressing climate change requires changing human behavior, including individual
3 action, collective action, and policy changes. Psychological interventions have the potential to
4 change behavior at scale. We systematically tested 17 psychological interventions, characterized
5 by three key themes (Figure 1): *Self- and Social-Relevance* (relating climate change to oneself
6 and close others), *Future Thinking* (imagining future actions and outcomes related to climate
7 change), and *Action Impact* (targeting beliefs about the environmental and personal benefits of
8 climate action). Our primary aims were to identify the most effective strategies to increase
9 intentions to engage in pro-environmental behaviors, the perceived impact of those behaviors,
10 and intentions to share information about climate change. Overall, we identified effective
11 interventions for all primary outcomes, and found that interventions that targeted multiple
12 mechanisms (e.g., thinking about future outcomes for oneself or close others) were generally
13 most effective. Notably, the Letter to Future Generation intervention was broadly effective
14 across all primary outcomes, although other interventions (e.g., News Comments, Guided
15 Imagination) had relatively stronger effects for specific outcomes.

16 **Motivating Pro-Environmental Behaviors**

17 We first investigated whether the interventions increased intentions to engage in pro-
18 environmental behaviors, including individual actions (e.g., driving less, eating vegetarian meals,
19 paying for green energy to power one's home) and collective actions (e.g., donating,
20 volunteering, contacting one's representatives). We found that engaging in future thinking—
21 especially—self- and socially-focused future thinking—effectively motivated climate action. Six
22 intervention conditions significantly increased intentions to engage in pro-environmental
23 behaviors; all six involved future thinking. The most effective intervention was the Prevention-

1 Self variant of the Guided Imagination intervention, which involved imagining oneself
2 experiencing a negative future scenario due to climate change. Another leading intervention was
3 the Letter to Future Generation condition, which emphasized future outcomes for a socially-close
4 child. Other future thinking interventions, such as engaging in action planning or brainstorming
5 near-future personal benefits, also motivated action.

6 The effectiveness of the future thinking interventions can be explained by multiple
7 distinct mechanisms, including increases in perceived risk, self-efficacy beliefs, or anger. Our
8 secondary outcome measures offer insight into potential mechanisms of action. Perceived risk
9 has previously been linked to climate action (88, 89); the two interventions that increased
10 perceived risk also increased action intentions (Guided Imagination, Prevention-Self; Action
11 Planning, Individual). Several major theories of behavior change, such as The Theory of Planned
12 Behavior (64, 90) and Social Cognitive Theory (91), propose that self-efficacy—beliefs about
13 one’s ability to take action effectively—drives motivated behavior. The two interventions that
14 led to the greatest increases in self-efficacy (Letter to Future Generation and Personal Benefits)
15 also increased action intentions. Future thinking interventions also modulated emotions about
16 climate change, such as by evoking anger (Guided Imagination, Prevention-Self; Letter to Future
17 Generation); anger is a high-arousal emotion associated with “approach” motivation, which can
18 catalyze action (92). Taken together, these findings suggest that engaging in self- and socially-
19 relevant future thinking may motivate action via several distinct mechanisms, such as by
20 increasing perceived risk, self-efficacy, or anger.

21 Contrary to our expectations, the leading future thinking interventions did not decrease
22 any aspects of psychological distance related to climate change, suggesting that the benefits of
23 future thinking were not driven by reducing psychological distance. These results contribute to

1 an ongoing theoretical debate about the importance of psychological distance in climate change
2 interventions; our findings align with recent evidence that psychological distance may be
3 overestimated and not always related to action intentions (55–57).

4 **Increasing Perceived Impact**

5 We also tested whether the interventions increased the perceived impact of pro-
6 environmental behaviors, assessing the same set of behaviors as for action intentions. Our
7 measure of perceived impact assessed *outcome expectancies*, a key predictor of behavior change
8 identified in major theories of behavior change, such as Social Cognitive Theory (91) and The
9 Theory of Planned Behavior (64, 90). We prompted participants to rate how much each action
10 would help to reduce the negative effects of climate change if many people engaged in the
11 action. This measure probes *collective response efficacy* (i.e., the expected positive outcomes
12 resulting from many people taking action), which prior work has theorized may be important for
13 motivating action to address large-scale societal problems like climate change (72, 93).

14 Most of the interventions tested in our tournament (76.5%, 13/17 interventions) increased
15 the perceived impact of pro-environmental behaviors. All interventions in the Action Impact
16 theme increased perceived impact; interestingly, even emphasizing *personal* impact (Personal
17 Benefits condition) also increased perceived *environmental* impact. Overall, the Letter to Future
18 Generation, Personal Benefits, Impact Quiz, and Moral Values interventions led to the greatest
19 increases in perceived impact.

20 Interestingly, results for perceived impact were distinct from results for action intentions.
21 For instance, the Carbon Footprint and Impact Information interventions, which both directly
22 provided information about the mitigation potential of pro-environmental behaviors,
23 substantially increased perceived impact but did not increase action intentions. Conversely, the

1 leading strategy for motivating action (Guided Imagination, Prevention-Self) did *not* increase
2 perceived impact. These results offer important theoretical implications, suggesting that although
3 beliefs about impact and efficacy are often correlated with behavioral intentions (91), changing
4 these beliefs may not be necessary or sufficient for motivating climate action.

5 **Motivating Information Sharing**

6 We also investigated whether the interventions increased intentions to share news articles
7 and petitions about climate change. For each article and petition, participants rated their
8 willingness to share the content broadly on social media or directly with someone they know.

9 The two variants of the News Comments intervention had the strongest effects on
10 intentions to share news articles. In these intervention tasks, participants wrote brief comments
11 about each news article (akin to writing a social media post), noting why each article was
12 relevant to themselves or people they knew. Prompting participants to reflect on self- and social-
13 relevance while viewing the news articles substantially increased sharing intentions. These
14 results replicate our prior work, adding to the extensive body of evidence (including
15 correlational, experimental, behavioral, neuroimaging, and cross-cultural findings) indicating
16 that perceived self- and social-relevance of information motivates sharing (16–20, 22).

17 Extending prior studies, we also found that the effects of the News Comments interventions
18 generalized, increasing intentions to share petitions during a subsequent task (i.e., without
19 writing comments about the petitions).

20 A recent global mega-study found that the most effective strategy for motivating
21 individuals to share information about climate change on social media was negative emotion
22 induction, which led to 12% greater sharing intentions relative to the control group (4). However,
23 this intervention also had a robust backfire effect on pro-environmental behavior. We also

1 assessed broadcast sharing intentions with a comparable rating scale; our leading intervention
2 (News Comments, Social-Relevance) had a stronger effect (16% increase in intentions to share
3 news, relative to the Control group) and did not decrease action intentions.

4 The Letter to Future Generation intervention, in which participants wrote a letter about
5 climate change to a socially-close child (as if the letter would be delivered in the future), also
6 substantially increased intentions to share news articles and petitions. Our results conceptually
7 replicate recent evidence that this intervention strategy motivated information sharing on social
8 media (4); we extend prior findings by demonstrating this effect with multiple real news articles
9 and petitions about climate change. Several other interventions that appealed to self-relevance
10 (Moral Values, Personal Benefits), also had small effects on sharing intentions.

11 Overall, interventions that appealed to self- and social-relevance were the most effective
12 for motivating people to share information about climate change. The leading interventions for
13 motivating information sharing (News Comments and Letter to Future Generation) also
14 increased the perceived self- and social-relevance of climate-related news, consistent with the
15 idea that perceived relevance is a mechanism driving intentions to share information (16–20, 22).

16 **Tournament Insights: Assessing Relative Effectiveness**

17 The urgency and global scale of climate change underscore the importance of identifying
18 the *most effective* strategies for changing behavior. An intervention tournament approach, in
19 which many strategies are systematically tested and compared, is ideal for addressing this
20 challenge. Intervention tournaments allow researchers to test competing hypotheses from distinct
21 theoretical frameworks and identify the most effective strategies. In contrast to independent
22 studies, in which results may be attributed to different samples, recruitment methods, tasks,

1 outcome measures, statistical analysis, location, or time of year, our tournament approach
2 enables clear comparison across interventions.

3 Crucially, in addition to identifying the most effective strategies for each goal, we also
4 identified *ineffective* strategies. For example, interventions that provide feedback about
5 individuals' carbon footprints are widely promoted by major environmental agencies, such as the
6 U.S. Environmental Protection Agency (80) and the World Wildlife Fund (81). Despite the
7 popularity of such tools—first developed and promoted by British Petroleum (82)—there is little
8 empirical evidence of effectiveness (83, 84). We demonstrate that this prevalent climate
9 communication strategy failed to motivate behavior change, aligning with recent concerns that
10 emphasizing individual carbon footprints could be ineffective and draw attention away from
11 systemic decarbonization efforts (85). Our results identify alternative, more effective
12 communication strategies that should be prioritized over carbon footprint information.

13 Our findings complement and extend insights from a recent cross-cultural study that also
14 used an intervention tournament approach (4). This recent study tested eleven interventions
15 across 63 countries, identifying several promising strategies for increasing belief in climate
16 change, policy support, and information sharing intentions. However, none of the interventions
17 tested in the prior tournament increased climate action (operationalized as completing math
18 worksheets in exchange for donations to a tree planting organization), and several of the
19 interventions *decreased* action. A strength of the previous climate action task was the direct
20 measurement of effortful behavior, but a limitation is that it did not direct participants toward
21 actions that they could repeatedly take in everyday life. Notably, in the prior study, some of the
22 most effective interventions for one outcome (e.g., information sharing) had robust backfire
23 effects on climate action. Our study builds on these valuable insights by testing a new set of

1 interventions—we identified several strategies that effectively motivated action, as well as
2 strategies that motivated information sharing without backfiring on action intentions.
3 Importantly, we also included a distinct and more extensive set of measures, investigating new
4 outcomes of interest (e.g., perceived impact of climate action, intentions to share news and
5 petitions, petition signing) and underlying mechanisms (e.g., self-efficacy beliefs, perceived risk,
6 emotions, psychological distance).

7 **Limitations and Future Directions**

8 A recent critique of psychological interventions to address societal challenges like
9 climate change is that such interventions focus on individuals (“i-frame”), potentially diverting
10 attention and support away from systemic change (“s-frame”) (94). We argue that both
11 individual- and systemic-level changes are necessary to address climate change, and that these
12 frames are neither independent nor in opposition (31, 95, 96). Collective action arises from the
13 coordinated actions of individuals; policy changes influence how individuals perceive issues and
14 social norms; individuals elect, contact, and lobby representatives to shape policy (31, 95–97).
15 We observed that several of our interventions broadly increased intentions to engage in
16 individual *and* collective actions to address climate change, suggesting that some interventions
17 can increase support for both forms of climate action.

18 In the present study, we measured intentions to engage in pro-environmental behaviors
19 (relative to current behavior). A strength of this approach is that we directed participants toward
20 behaviors that they could realistically engage in regularly in daily life (e.g., driving less, eating
21 more vegetarian meals, sharing news articles). However, a limitation is that we measured
22 intentions as opposed to observable behavior. Behavioral intentions are reliably related to actual
23 behavior (64, 90, 98), but other factors (e.g., effort, cost, forgetting) may prevent individuals

1 from acting on their intentions. It is also worth noting that we observed small-to-medium effect
2 sizes for leading interventions across outcome measures. However, even small effects can have
3 substantial impact at scale: brief online interventions can be distributed to large audiences,
4 individuals engage in actions habitually in daily life, and the effects of sharing information
5 spread through social networks (99, 100). Future studies could test the leading interventions
6 identified in our tournament with direct measures of effortful behavior (e.g., donations to
7 environmental organizations, signing up for home renewable energy programs) and longitudinal
8 measures (e.g., using ecological momentary assessments).

9 In our sample, we aimed to approximate the demographic diversity of the United States
10 (in terms of age, race, and gender; see Table S1). However, there are several limitations:
11 Hispanic/Latino participants were underrepresented in our sample, and we lack sufficient
12 statistical power to investigate demographic differences across conditions. In addition, the
13 distribution of political ideology was not representative of the nation (our sample included more
14 liberals than conservatives), and we excluded participants who reported denying the existence of
15 anthropogenic climate change. Climate change is a politically polarized issue; in the U.S. and
16 globally, conservatives are less likely to believe in climate change, perceive climate change as a
17 threat, and support action to address climate change (101, 102). In ongoing work, we are
18 investigating strategies to bridge the partisan divide and replicating promising interventions in
19 politically-balanced samples that include individuals who are skeptical or uncertain about the
20 causes and impacts of climate change.

21 **Conclusion**

22 Results from our tournament offer actionable insights for scalable behavioral
23 interventions and climate communication. We found that the most effective strategies to

BEHAVIORAL INTERVENTIONS FOR CLIMATE CHANGE

1 motivate action to address climate change involved guiding people to think about future
2 outcomes, particularly for themselves and close others. Reflecting on social relevance (relating
3 climate change to people you know) was the most effective strategy to motivate people to share
4 news articles and petitions about climate change.

5 The interventions tested in our tournament integrate diverse theoretical frameworks from
6 across topic areas. Our findings are broadly relevant to psychological theories of behavior
7 change, motivation, social behavior, decision making, learning, and information sharing. Our
8 findings also offer practical and actionable implications for communicators, policymakers, and
9 environmental scientists. Importantly, the promising interventions identified in our tournament
10 could be adapted to create accessible, engaging, and interactive online tools. Our interventions
11 were administered in a web browser and all tasks took approximately 5 minutes; these
12 interventions could be readily scaled to reach broader audiences, applying evidence-based
13 strategies to motivate action to address climate change. Overall, we recommend illustrating
14 future scenarios and emphasizing the personal and social impact of climate change as leading
15 strategies to promote behavior change and information sharing.

16

Materials and Methods

Participants

Detailed information about the sampling procedure, power analyses, and demographics are reported in the SI Appendix. The study was approved by the Institutional Review Board at the University of Pennsylvania (protocol number #854102). In brief, we recruited online paid participants through Prolific who were U.S. residents, fluent in English, ages 18+, had high prior task approval ratings, and reported believing in climate change. We used quota sampling to stratify our sample by gender and age group, recruiting participants across the adult lifespan (ages 18-88). Participants provided informed consent by clicking a button at the start of the task. Participants were compensated with \$5 for a study that took approximately 25 minutes to complete (a rate of approximately \$12/hour).

Data collection took place in two phases. In the first phase of data collection (February 2024), we tested six overarching intervention strategies. To determine the most effective implementation of each intervention strategy, we also tested multiple variations within each “parent” intervention. Participants were randomly assigned to one of fourteen intervention groups or the no-intervention Control group. In the second phase of data collection (June 2024), we tested three additional late-breaking intervention ideas (without variations). We pooled data from the two samples to compare results from all interventions (9 broad intervention strategies, 17 groups in total) with the same Control group.

We excluded participants for the following criteria (see SI Appendix, *Exclusions*): failed attention checks (n=15), denial of anthropogenic climate change (n=94), off-task behavior that may indicate cheating or distraction (n=58), poor-quality written responses (n=100), self-reported dishonesty (n=39), or more than one reason (n=15). After exclusions, the final sample

1 included 7,624 participants (6,443 in sample 1; 1,181 in sample 2). Demographic information is
2 provided in Table S1.

3 **Procedure**

4 Below, we briefly describe each intervention task, grouped by the three key themes: *Self-*
5 *and Social-Relevance*, *Future Thinking*, and *Action Impact*. Note that some interventions can be
6 described by multiple themes (Figure 1); for simplicity, below we group interventions by
7 primary themes. Additional methodological details are provided in the SI Appendix (*Procedure*).

8 ***Self- and Social-Relevance Theme***

9 In the **News Comments** interventions, participants viewed news headlines about climate
10 change and wrote brief comments about the headlines. These interventions were based on prior
11 evidence that reflecting on the self- and social-relevance of information motivates sharing (16–
12 18, 20). In the Self-Relevance condition (N=396), participants described why the headlines
13 mattered to them; in the Social-Relevance condition (N=392), participants described why the
14 headlines mattered to people they know.

15 In the **Social Norm Information** interventions, participants viewed statistics from recent
16 U.S. national polls, describing normative attitudes about climate change (e.g., policy support,
17 climate change denial). These interventions were based on evidence that people tend to
18 underestimate normative belief and concern about climate change, and changing perceived social
19 norms could motivate action (12–14, 103). In the Norm Quiz condition (N=426), participants
20 guessed a missing statistic before the correct answer was revealed; in the Norm Text condition
21 (N=428), participants viewed intact statements.

22 In the **Moral Values** intervention (N=420), participants read brief descriptions of six
23 moral values adapted from Moral Foundations Theory (104, 105): Care/Compassion, Equality,

1 Proportionality, Loyalty, Authority/Tradition, and Purity/Sanctity. This intervention was based
2 on evidence that relating climate change to one's moral values could change attitudes and
3 potentially overcome political partisanship (106). Participants selected the moral value that was
4 most important to them, completed a writing exercise relating their chosen moral value to
5 climate change, and then read a short persuasive message that further described how their chosen
6 moral value was related to climate change.

7 ***Future Thinking Theme***

8 In the **Guided Imagination** interventions, participants completed a structured
9 imagination exercise. These interventions were based on evidence that engaging in *episodic*
10 *simulation* (i.e., imagining hypothetical or future scenarios) can motivate pro-environmental
11 behaviors (48, 107), change beliefs about risk (46, 47, 108), and motivate prosocial behaviors
12 (49, 50). In the Prevention-Self condition (N=380), participants imagined themselves experiencing
13 a negative future that could occur if society fails to take action to address climate change. In the
14 Promotion-Self condition (N=373), participants imagined themselves experiencing a positive future
15 that could occur if society successfully takes action to address climate change. In the Prevention-
16 Other (N=374) and Promotion-Other (N=374) conditions, participants imagined a fictional
17 character in the same negative and positive future scenarios, respectively.

18 In the **Action Planning** interventions, participants developed a plan to achieve a goal and
19 imagined the process. These interventions were adapted from *Mental Contrasting with*
20 *Implementation Intentions* interventions, which have been shown to motivate behavior change
21 (109–112). Participants selected an action from a list of recommended actions to mitigate climate
22 change, then imagined and described how they personally might engage in the process of
23 engaging in the action, potential obstacles and how they could be overcome, and the eventual

1 outcomes of the action. In the Individual Action Planning condition (N=393), participants
2 selected an individual action goal (e.g., taking a train instead of flying, eating less red meat),
3 whereas in the Collective Action Planning condition (N=382) they selected a collective action
4 goal (e.g., donating, volunteering, contacting representatives).

5 In the **Letter to Future Generation** intervention (N=391), participants identified,
6 described, and wrote a brief letter to a child or teenager they personally knew. This intervention
7 was adapted from a task that was previously shown to increase climate-related policy support
8 and information sharing (92). Participants imagined that their letter would be delivered in the
9 year 2050, when the child would be an adult with a family of their own. In the letter participants
10 were asked to tell the child about their personal efforts to address environmental problems with
11 the goal of ensuring that the child would inherit a habitable planet, as well as how they wanted to
12 be remembered as someone who did their best to ensure a safe and flourishing world.

13 *Action Impact Theme*

14 In the **Impact Information** interventions, participants learned about the impact (in terms
15 of mitigating greenhouse gas emissions) of various actions that individuals could take to help
16 mitigate climate change. These interventions were based on evidence that challenging beliefs
17 with surprising feedback can correct misconceptions (113–115). In the Impact Quiz condition
18 (N=416), participants guessed the values before impact estimates were revealed; in the Impact
19 Text condition (N=418), participants viewed intact statements.

20 In the **Carbon Footprint** interventions, participants learned about actions that they could
21 take to reduce their carbon footprints. These interventions were included in the tournament
22 because carbon footprint estimators are widely used and promoted by organizations like the
23 Environmental Protection Agency (80) and World Wildlife Fund (81), despite limited evidence

1 of effectiveness. In the Personalized Carbon Footprint condition (N=413), participants received
2 personalized feedback about their current carbon footprint and how various actions would reduce
3 it. In the General Carbon Footprint condition (N=428), participants received feedback calculated
4 for an average U.S. resident.

5 In the **Personal Benefits** intervention (N=370), participants generated short-term
6 *personal* benefits (e.g., improving health, happiness, relationships, or finances) that could arise
7 from engaging in pro-environmental behaviors. This intervention was based on evidence that
8 people tend to overvalue short-term rewards and discount long-term outcomes (116), as well as
9 evidence that positive attitudes toward behaviors (64) and short-term rewards can increase goal
10 pursuit (41–43). For each action, participants were instructed to write down as many personal
11 benefits as possible, thinking of the effects of engaging in the action regularly over the next six
12 months.

13 ***Outcome Measures***

14 After completing an intervention task (or after consent in the no-intervention Control
15 group), participants completed the Climate Action, News Headlines, and Petitions Tasks
16 (described below) in a randomized order. In the News Comments interventions, however,
17 participants always completed the News Headlines task first, because these interventions
18 modified this task by adding a writing component. After the primary tasks, participants
19 completed a series of secondary measures in a randomized order. In addition to the measures
20 described below, we collected additional measures for exploratory analyses. Additional
21 information is provided in the SI Appendix.

22 **Climate Action Task.** Participants were asked about 12 actions that could have positive
23 or negative effects on climate change, including individual actions (e.g., eating vegan meals,

1 flying by airplane, paying for renewable energy to power one’s home) and collective actions
2 (e.g., donating, volunteering, or contacting representatives). In a pilot study, we assessed beliefs
3 about various pro-environmental behaviors, identifying actions that were feasible but not yet
4 widely adopted (i.e., few people already engage in the action as much as possible). From this list
5 of actions, we selected a subset of target actions that were recommended by climate scientists
6 and associated with greater reduction of greenhouse gas emissions (86).

7 Actions were presented in a randomized order, with a single action presented per page.
8 Participants reported their current frequency of engaging in each action (e.g., typical driving
9 habits, annual donations to environmental organizations), using custom scales for each action.
10 Participants then used 7-point Likert scales to rate their intentions to engage in the action
11 more/less in the future (1=*A lot less*, 7=*A lot more*) and the perceived environmental impact if
12 many people did the action more/less often (1=*No impact*, 7=*Very large impact*). Actions were
13 framed in terms of engaging “more” or “less” depending on which direction would indicate pro-
14 environmental behavior (e.g., driving *less*, donating *more*).

15 **News Headlines Task.** Participants viewed a set of five news headlines about climate
16 change (consisting of a title and an accompanying lede), randomly selected from a larger set of
17 26 headlines sourced from the New York Times. For each article presented, participants used a
18 scale from 0 (*strongly disagree*) to 100 (*strongly agree*), to rate their intentions to share the
19 article broadly on social media (“broadcast” sharing) or directly with someone they know
20 (“narrowcast” sharing). Using the same rating scales, participants also rated the perceived self-
21 relevance and social-relevance of each news article.

22 **Petitions Task.** Participants viewed three petitions about climate change (screenshots of
23 real petitions sourced from *change.org* accompanied by abbreviated text), randomly selected

1 from a larger set of 10 petitions. For each petition presented, participants used a scale from 0
2 (*strongly disagree*) to 100 (*strongly agree*), to rate broadcast sharing intentions, narrowcast
3 sharing intentions, and intentions to sign the petition. Participants also had the option to click a
4 link to view the petition and sign it; however, due to a programmatic error, not all click-tracking
5 data were saved. Results for link clicks are reported in the SI Appendix.

6 **Secondary Measures.** Secondary measures for exploratory analyses included scales
7 assessing self-efficacy, perceived risk, emotions, psychological distance, self-reported
8 knowledge, and uncertainty/skepticism regarding climate change. Participants also completed a
9 standard demographics survey.

Statistical Analysis

10 ***Open Science Practices***

11 Data, code, and fitted Bayesian models are publicly available in a permanent repository
12 hosted by the Open Science Framework (<https://osf.io/x9c6j/>). Overall analyses of the entire
13 tournament sample were not preregistered. However, we preregistered the methods and
14 predictions for most individual interventions; these preregistrations include some additional
15 condition-specific analyses that are beyond the scope of this report
16 (<https://osf.io/x9c6j/registrations>). Survey/task materials and additional information about
17 standard operating procedures can also be found within the project repository.

18 ***Preprocessing***

19 For measures of current action frequency from the Climate Action Task, we z-scored
20 values within-item to account for discrepancies in scale (e.g., dollars donated vs. miles driven),
21 then included this standardized current frequency variable in statistical models as a covariate.
22 Individual open-ended numeric responses (i.e., amount of money donated or paid for renewable

1 energy and the number of flights taken) that were implausibly high were winsorized to the 99th
2 percentile (13 observations for donations, 13 observations for energy, and 68 observations for
3 flights). For analyses of action intentions, we excluded trials in cases where it was not possible
4 for the participant to engage in the action more in the future (i.e., current behavior was reported
5 at the maximum possible level). For example, an individual who does not own a car and never
6 drives cannot reduce driving further; an individual who always eats a vegan diet cannot reduce
7 meat consumption further. However, we also conducted the same analyses with these “maxed-
8 out” actions included and obtained results that were consistent with the results reported in the
9 main text (see Table S15).

10 *Statistical Modeling*

11 Analyses were conducted in R (version 4.4.1), implemented with RStudio (version
12 2024.04.2). We used Bayesian analyses to estimate intervention effects for each outcome
13 measure, comparing each intervention group with the Control group. We used a Bayesian
14 approach because the goal of the study was to estimate the effectiveness of each intervention
15 approach, focusing on effect *magnitude* rather than the presence or absence of an effect. We
16 report results with point estimates (median of posterior distribution) for each group and the 95%
17 credible interval. We interpret effects as significantly different from the Control group if the
18 lower bound of the 95% credible interval is greater than the Control group point estimate. For all
19 analyses, we used weakly-informative priors (Gaussian distribution with $M=0$, $SD=1$). We used
20 linear mixed-effects regression models (for tasks with multiple observations per participant) and
21 linear regression models (for tasks with single observations or composite scores). Additional
22 information about random effects specification and software packages is provided in the SI
23 Appendix (*Statistical Analysis*).

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Author Contributions

All authors contributed to conceptualization, investigation, and methodology. JCT and AHS led data collection. AHS, DC, and KL contributed to data analysis in discussion with EBF. AHS contributed to data visualization. EBF contributed to funding acquisition. EBF, AHS, and DC contributed to project administration. AHS primarily drafted the manuscript, with contributions from DC, KL, and DAR. EBF and MEM contributed to reviewing and revising the manuscript. All authors reviewed and approved of the manuscript prior to submission.

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Competing Interests

The authors declare no competing interests.

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