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A psychologically wise intervention to inform relational organizing in the face of climate and ocean change

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Widespread climate action is broadly recognized as necessary to reduce climate change impacts on oceans ("ocean change"), but threats to ocean ecosystems are commonly perceived as distant, irrelevant, and unchangeable. Communicating about ocean change, therefore, requires message framing strategies targeting evidence-based psychological precursors to behavior. In a pre-registered case study of coastal visitors in Oregon, United States ($n = 2414$), we tested the influence of psychologically wise message about ocean change on climate action intentions. We primarily focused on influencing relational organizing: people's willingness to encourage others to act. A behavior-specific message targeting relational organizing efficacy beliefs significantly but weakly increased intentions for relational organizing regarding ocean change compared to a control. Neither a connectedness to coast (place-based) message nor an ocean acidification (proximate threat-based) message had detectable effects on intentions. Our results suggest that targeting relational organizing efficacy may increase climate action intentions for the protection of coastal ecosystems.

Marine ecosystems and the people who depend on them are facing the impacts of climate change, including sea level rise, coastal flooding, ocean acidification, coastal erosion, temperature changes, and sea current and weather changes, to name a few[1]. These impacts are complex, multifaceted, and vary spatially and temporally, making climate change's impacts on the ocean (hereafter referred to as "ocean change") "wicked" problems to adapt to and mitigate[2]. Although wicked problems are largely attributable to macro-level causes (e.g., the fossil fuel emissions of large corporations), individual people can still powerfully contribute to coordinated collective efforts that pressure institutional and infrastructural changes[3,4]. For instance, public engagement with marine issues can enable more responsive marine and coastal management priorities that account for public values[5] and increase collective action toward the mitigation of and adaptation to climate change[6] (e.g., local marine stewardship initiatives[7]). Actions taken by individuals to support climate change mitigation and adaptation (i.e., "climate actions")[8] lead to a sustainable future for the ocean.

Encouraging widespread action for ocean change is a challenging endeavor. Many climate actions—such as climate-conscious food choices[9], climate conversations and encouragement of actions within social networks (i.e., "relational organizing")[10,11], and participation in collective climate activism[12]—indirectly help to mitigate ocean change by addressing broader climate change issues. Connecting these actions to their ocean-related impacts can be difficult, especially considering the ocean is not a part of many people's daily environment. Consequently, the ocean is often conceived of as an abstract concept[13], and the problems occurring in these distant environments can become "out of sight, out of mind" issues—a phenomenon termed *psychological distance*[14]. In line with psychological distance theory, the more abstract the ocean (or some other concept) is to a person, the more distant it is perceived to be from themself[15–18]. The psychological distance of climate change, more broadly, has been frequently observed by researchers. Across a range of studies, people view climate change as uncertain, likely occurring far in the future, impacting distant places, and affecting people dissimilar to themselves[15,19–21]. Furthermore, compared to land-based climate change impacts such as wildfires, heatwaves, and droughts, ocean change is less visible and directly experienced, reinforcing the perception that it is less personally relevant[22] and that individual actions are trivial[23]. Strategies for overcoming the psychological distance of ocean change to effectively inspire people to take action have received little attention. In this paper, we approach the following question: How can people be motivated to engage in collective climate action in response to ocean change, a threat that is often perceived as distant, irrelevant, and unchangeable?

One classical strategy for motivating people to engage in certain actions is *strategic message framing*. Strategic message framing is communication

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tailored to the context of the issue of interest, the actions the audience might take, and the audience's values and motivations in connection to these actions to make the issue more salient[24]. Rooted in marketing research[25], message framing has been applied to a variety of fields such as public health[26–28], politics[29], and more recently to the contexts of environmental sustainability[30–32], natural resource management[33], and conservation[13,34,35]. Message framing can be *psychologically informed*, in that it draws on psychological concepts that are relevant to the audience, and it can further be *psychologically wise*, meaning it is "psychologically precise, often brief, and often aims to alter self-reinforcing processes" to create long-term change in how people see themselves and how they act[36]. Psychologically wise interventions rely on a higher standard of evidence because they are precisely tailored and experimentally tested, thereby providing "a theoretical account of what will work with whom and when"[37]. In this study, we compare a psychologically wise message frame for motivating action in response to ocean change against two psychologically informed frames and a control. Our case study experimental survey of visitors to the coast of Oregon, USA—a socially valued place experiencing the local impacts of ocean change—provides insight for psychologically wise ocean change communication.

A recurrent approach to climate and conservation communication is providing factual information to give the audience a deeper understanding of the issue, referred to as the *knowledge-deficit model*[38]. For those without communication research training, inspiring public engagement may seem intuitive, as it is assumed people must comprehend a problem to care and take action. However, the knowledge-deficit model's ability to significantly influence behavior or advocacy has been largely debunked[39,40]. From a psychological standpoint, simply increasing knowledge and awareness is unlikely to lead to concern or direct action[39,41], particularly for 'out of sight' issues commonly perceived as personally irrelevant.

Based on psychologically informed or psychologically wise approaches, this study considers three strategies for ocean change communication and compares them to a non-psychologically based approach. First, given the continual fallback to the deficit-style approach, restructuring this approach to be audience- and context-specific could be a practical way to make it more psychologically informed. Narrowing the focus of ocean change communication to a proximate and present threat (i.e., tailoring to the context of the communication scenario) may bring personal relevance to the information and make the concept more concrete. For example, Velautham et al.[42] showed that providing information about sea level rise, a widely apparent and localized effect of ocean change, resulted in increased acceptance of sea level rise as a concerning phenomenon that is caused by climate change. Further, Jones et al.[15] found that a video emphasizing climate change events that had recently occurred in Australia reduced its psychological distance, thereby increasing climate mitigation intentions, compared to a video presenting climate change events that had taken place overseas to people of other cultures.

One effect of ocean change that is largely unfamiliar among Americans, but inflicts localized impacts, is ocean acidification[43]. Although there are generally low levels of awareness about ocean acidification in the U.S.[44], studies on public perceptions have shown positive relationships between knowledge about ocean acidification and emotions, attitudes, and norms regarding this impact[45]. Ocean acidification is, moreover, an increasing concern for ecosystems in Oregon where this study took place[46,47]. Thus, presenting ocean acidification as a present and proximate threat of ocean change and providing compelling factual information about its impacts could be one psychologically informed strategy to transcend the basic knowledge-deficit model by tailoring ocean change to be less abstract and more relevant, thereby increasing intent to act.

Hypothesis 1: An ocean change message that focuses on ocean acidification will lead to higher intentions to engage in climate action than a control message.

A second framing strategy for ocean change communication may be to make the ocean more psychologically "close" to people. People can have deeply-held cognitive and emotional attachments with certain places. The psychological distance of ocean change might, therefore, be reduced by reminding the audience of their direct and indirect cognitive and emotional connections to the ocean. Sense of place—the affective connections between a person and a location—can motivate care for the environment[48], predict pro-environmental behavior[49], and indicate community resilience[50]. If a place is perceived to be threatened, it can stimulate strong cognitive and emotional responses[51]. Evoking a person's sense of place could remind them of their relationship with a place and lead to increased concern when this relationship is threatened.

The seashore or coast has attracted humans for centuries and, for many people, evokes a strong sense of place. Coastal places can prompt feelings of awe, humility, and wonder[52], inspire an identity associated with the ocean (e.g., ocean identity[53]), and induce a dependence on the coast's functionality[54]. Hereafter, we will refer to the emotional, symbolic, and functional attachments between people and the coast as their "connectedness to the coast." Prompting connectedness to the coast could be a psychologically informed approach to motivating climate action by closing the psychological distance of ocean change.

Hypothesis 2: An ocean change message that focuses on connectedness to the coast will lead to higher intentions to engage in climate action than a control message.

Reducing psychological distance and increasing sense of place are two strategies for making climate communication more psychologically informed. A third approach to action-oriented ocean change communication is reinforcing beliefs that certain actions are realistic, doable, and impactful. People are driven by a fundamental need to believe in their own competence and ability to achieve their goals[37]. Promoting a strong sense of self-efficacy (i.e., the belief in one's capacity to do a certain action[55,56]) and personal response efficacy (i.e., the belief that one's action will contribute to the desired outcome[57]) is therefore likely to influence a person's belief in their ability to take climate action and positively contribute to ocean change. This may be particularly important for ocean change communication, since climate change is often perceived as too large and complex a problem for individuals to address[58], and skepticism about the actions individuals could take to help mitigation efforts may perpetuate an unwillingness to take action[59,60]. These perceptions may be particularly compounded in the profoundly psychologically distant context of ocean change. To overcome these perceptions, ocean change interventions could transcend from psychologically informed to psychologically wise by moving beyond the use of individual predictors of action to a more deliberate use of behavior-specific predictors of action (e.g., behavior-specific efficacy beliefs).

Personal efficacy beliefs are shown to be positively associated with private-sphere actions, such as recycling more often[61] and eating a plant-based diet[62]. However, suggestions on what individuals can do about climate change commonly fail to consider the feasibility (or rather, difficulty) of taking those suggested actions[63], a critical component of a psychologically wise intervention. Compared to private-sphere actions that are often context- and audience-dependent, a more widely applicable climate action to target could be relational organizing – a form of social diffusion by which people engage in the action of encouraging others to take action[11]. Although it does not directly affect the environment, as a public-sphere action, relational organizing is powerful in its ability to induce more widespread engagement in climate action within groups of people[64]. Relational organizing and other diffusion behaviors can generate a positive feedback loop on an individual's efficacy beliefs: as they talk to others about taking climate action, they can learn more about the topic themselves and feel more confident in their own ability to take further action[65]. Increasing an individual's relational organizing efficacy beliefs (i.e., their perceived ability to successfully convey a message that encourages others to take action[11]) could increase both their own personal efficacy beliefs in taking action[66] and the efficacy beliefs of the people they are encouraging (i.e., social learning)[55].

Hypothesis 3: An ocean change message that focuses on increasing relational organizing efficacy beliefs will lead to higher intentions to engage in climate action than the control.

Relational organizing challenges the knowledge-deficit model: rather than experts transmitting information, motivated people are sharing

Table 1 | Predicting the intention of engaging in relational organizing behavior amongst visitors to the Oregon coast

		Dependent variable: Relational organizing intention[a]					
Independent variable	***M*[a]**	***r***	***B***	***β***	**SE**	***t* value**	***p* value**
(Constant)[b]	3.29	−0.04	3.29	–	0.05	68.12	<0.001
Experimental condition							
Condition 2 (Ocean acidification)	3.39	0.01	0.10	0.04	0.07	1.48	0.140
Condition 3 (Connectedness to the coast)	3.35	−0.01	0.07	0.02	0.07	0.94	0.345
Condition 4 (Relational organizing efficacy beliefs)	3.45	0.04	0.16	0.06	0.07	2.34	0.019

[a]$R^2 = 0.002$; Adj. $R^2 = 0.001$; $F_{3, 2406} = 1.93$, $p = 0.124$.
[b]Reference variable represents comparisons to the control message.

information and encouraging their community to engage in action(s) with them[67]. People are more likely to comply with requests from individuals they know or perceive to be similar to themselves[68] and actions are perceived as more attainable when similar others are engaging in those actions[67]. Framing an ocean change message to foster the audience's relational organizing efficacy beliefs may have the power to simultaneously increase their knowledge about ocean change, perceived personal importance of its impacts, and personal efficacy beliefs to take action; a psychologically wise communication strategy making it more effective than other frames.

Hypothesis 4: An ocean change message that focuses on increasing relational organizing efficacy beliefs will lead to the highest intentions to engage in climate action of all three treatment messages.

Results

Main effects of experimental messages

Of the three experimental messages implemented in our case study, only the message focused on relational organizing efficacy beliefs (condition 4) significantly predicted relational organizing intention (Table 1 and Fig. 1). Respondents who received the relational organizing efficacy condition showed a 0.16 higher score in their relational organizing intention compared to respondents who received a control message about Oregon's marine reserve system ($B = 0.16$, $p = 0.019$, $r = 0.04$). Taken together, the messaging conditions only accounted for 0.2% of the variance, suggesting a very weak relationship between the experimental condition and subsequent intention.

Effects of experimental messages on a proxy for real-world relational organizing

Respondents' choice of one of two stickers containing statements encouraging others to take climate action versus a control sticker would indicate their interest in engaging in relational organizing behavior. A multinomial logistic regression showed only a statistically significant difference in sticker choice odds between message conditions for participants who chose the tides sticker after receiving the ocean acidification condition (condition 2) compared to participants who chose the same sticker but received a different message condition (Table 2). However, among the participants who received the ocean acidification condition, there was no significant difference in choosing the tides sticker over another sticker ($B = 0.05$, $p = 0.107$). These results indicate that the message condition that a participant received was not significantly related to their sticker choice.

Impact of experimental messages on additional individual, interpersonal, and communal climate actions

Exploratory linear regression analyses of message condition on three other climate action intentions indicated that relative to the control, the experimental messages increased respondents' intended frequency of engaging in a private-sphere individual-level action (i.e., making food choices to reduce one's carbon footprint) and in interpersonal communication (i.e., talking to others about ocean change), but not in a public-sphere community-level action (i.e., participating in a community-organized climate activity) (Table 3). Intended frequency of individual-level action was significantly

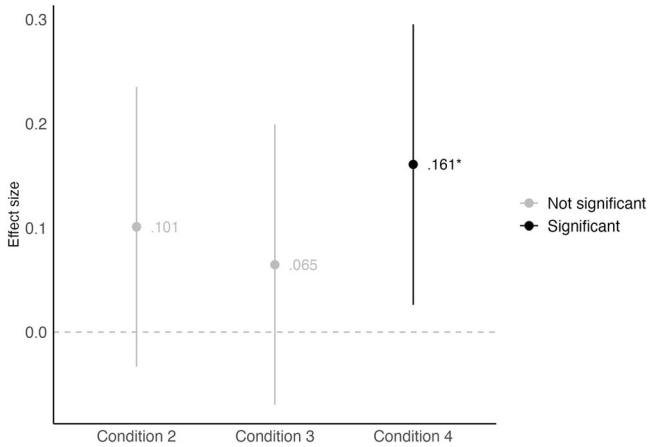

Fig. 1 | Effect of the experimental message conditions on relational organizing intention, compared to the control condition (dashed gray line). Error bars represent confidence intervals. *$p < 0.05$.

and most strongly predicted by the relational organizing efficacy message (condition 4) ($B = 0.26$, $p = 0.005$) followed by the connectedness to the coast message (condition 3) ($B = 0.21$, $p = 0.020$), but not by the ocean acidification message (condition 2) ($B = 0.14$, $p = 0.121$). Intended frequency of interpersonal communication was only significantly associated with the relational organizing efficacy message (condition 4) ($B = 0.18$, $p = 0.012$). In line with our main analyses, relationships between message condition and outcome were weak in all three models. Message condition accounted for only 0.4% of the variance in individual-level action and 0.3% of the variance in interpersonal communication.

Validation of message conditions

Analysis of variance (ANOVA) tests showed no significant differences in participants' marine reserves perceptions across treatment conditions (Self-assessed knowledge: $F_{2, 1783} = 0.12$, $p = 0.889$; Opinion: $F_{2, 1766} = 0.15$, $p = 0.860$; Geographic knowledge: $F_{2, 1729} = 0.10$, $p = 0.908$). Additionally, participants' scores for each psychological construct did not significantly differ between conditions not intended to target the construct (Ocean acidification perceptions: $F_{2, 1788} = 0.91$, $p = 0.403$; Connectedness to the coast: $F_{2, 1811} = 1.27$, $p = 0.280$; Efficacy beliefs: $F_{2, 1810} = 0.19$, $p = 0.827$). We interpret these results as validation of our marine reserves message as an a-theoretical control condition with no call to action.

Respondents who received the ocean acidification message (condition 2) were more likely to have higher scores for their ocean acidification perceptions after reading the message compared to respondents who received one of the other conditions ($B = 0.14$, $p < 0.001$), although this relationship was weak ($r = 0.08$; Table 4). Those who received the relational organizing efficacy message (condition 4) were more likely to have higher efficacy beliefs relative to the other conditions ($B = 0.18$, $p = 0.005$, $r = 0.06$). No significant association was found between the connectedness to the coast message

Table 2 | Relative risk ratios of sticker choice between message conditions

Characteristic	Odds ratio	95% CI		p value
		Lower	Upper	
Mussels sticker				
Condition 2 (Ocean acidification)	1.27	0.88	0.88	0.200
Condition 3 (Connectedness to the coast)	1.34	0.93	0.93	0.115
Condition 4 (Relational organizing efficacy beliefs)	1.08	0.74	0.74	0.689
Tides sticker				
Condition 2 (Ocean acidification)	1.31	1.00	1.00	0.049
Condition 3 (Connectedness to the coast)	1.24	0.94	0.94	0.131
Condition 4 (Relational organizing efficacy beliefs)	1.15	0.88	0.88	0.303

(condition 3) and actual perceived connectedness to the coast ($B = 0.02$, $p = 0.739$, $r = 0.01$). These results suggest that the experiment is considered a fair test of our first, third, and fourth hypotheses, but may not be considered a fair test of our second hypothesis because the messaging experiment failed to predict the intended psychological construct.

Discussion

Combating the wicked problem of ocean change requires widespread collective engagement in climate action. In this experimental study, we sought to test the impact of short-duration psychologically informed and psychologically wise messages on climate action intentions among a subsection of the population—coastal beach visitors—who might be expected to be concerned about ocean change. We found that, compared to a control message about local marine reserves, a psychologically wise message targeting relational organizing efficacy increased climate change relational organizing intention. Conversely, psychologically informed messages targeting connectedness to the coast (i.e., a metric of place identity, attachment, and dependence) and ocean acidification (i.e., a proximate threat of ocean change) failed to influence post-message relational organizing intention.

Table 3 | Intended frequency of engaging in individual, interpersonal, and community-level climate actions

		Dependent variable: Intended frequency of climate action[a]					
	M	r	B	β	SE	t value	p value
Individual-level action							
(Constant)	3.82	−0.05	3.82	–	0.07	58.67	<0.001
Experimental condition							
Condition 2 (Ocean acidification)	3.96	−0.01	0.14	0.04	0.09	1.55	0.121
Condition 3 (Connectedness to the coast)	4.03	0.02	0.21	0.06	0.09	2.32	0.020
Condition 4 (Relational organizing efficacy beliefs)	4.08	0.04	0.26	0.07	0.09	2.78	0.005
Interpersonal communication							
(Constant)	3.29	−0.04	3.29	–	0.05	65.52	<0.001
Experimental condition							
Condition 2 (Ocean acidification)	3.42	0.003	0.13	0.05	0.07	1.85	0.064
Condition 3 (Connectedness to the coast)	3.41	0.01	0.12	0.04	0.07	1.74	0.083
Condition 4 (Relational organizing efficacy beliefs)	3.47	0.03	0.18	0.06	0.07	2.51	0.012
Community-level action							
(Constant)	2.29	−0.03	2.29	–	0.05	50.68	<0.001
Experimental condition							
Condition 2 (Ocean acidification)	2.34	−0.01	0.05	0.02	0.06	0.82	0.415
Condition 3 (Connectedness to the coast)	2.35	−0.004	0.05	0.02	0.06	0.85	0.395
Condition 4 (Relational organizing efficacy beliefs)	2.41	0.04	0.12	0.05	0.06	1.82	0.069

[a]Individual-level action: $R^2 = 0.004$; Adj. $R^2 = 0.002$; $F_{3,\ 2379} = 2.98$, $p = 0.030$; Interpersonal communication: $R^2 = 0.003$; Adj. $R^2 = 0.002$; $F_{3,\ 2382} = 2.30$; $p = 0.075$; Community-level action: $R^2 = 0.001$; Adj. $R^2 = 0.001$; $F_{3,\ 2378} = 1.10$, $p = 0.346$.

Table 4 | Average ocean acidification perceptions (OAP), connectedness to the coast (CC), and efficacy beliefs (EB) across the four message conditions

	OAP			CC			EB		
	M[a]	SD	r	M	SD	r	M	SD	r
Condition 1 (Control)	−0.07	0.80	−0.04	5.85	1.13	0.02	4.28	1.42	−0.03
Condition 2 (Ocean acidification)	0.09	0.75	0.08	5.82	1.17	0.01	4.33	1.42	−0.01
Condition 3 (Connectedness to the coast)	−0.06	0.85	−0.03	5.82	1.18	0.01	4.31	1.41	−0.02
Condition 4 (Relational organizing efficacy beliefs)	−0.01	0.82	−0.00	5.75	1.18	−0.03	4.49	1.35	0.06

[a]Mean OAP exhibits z-scores. Mean CC and EB are on increasing scales from 1 to 7.

The efficacy condition also increased behavioral intentions to engage in individual and interpersonal action, but not intended communal action, while the connectedness to the coast condition only increased intended individual action. The proximal threat condition about ocean acidification had no effect on these other intended actions. None of the treatment messages increased the selection of a reminder sticker at the end of the survey, which was intended to measure actual commitment to engage in climate action around ocean change.

The primary implication of these results is the potential of a psychologically wise message targeting relational organizing efficacy to increase behavioral intention to engage in climate action. One potential explanation for this message's apparent effect may be that it focused on a behavior-specific belief (i.e., relational organizing efficacy) to increase intentions of that behavior (i.e. relational organizing), which has previously been observed for diffusion-specific efficacy messaging[68]. The significant, albeit weak, effect is also consistent with correlational and experimental research finding associations between efficacy beliefs and climate action intentions or other pro-environmental behavioral intentions. In an experimental study testing six different psychologically wise messages among U.S. adults, only messages targeting self-efficacy and response efficacy increased intentions to reduce fossil fuel use in comparison to a control (other messages targeted response cost, maladaptive response rewards, severity, and susceptibility)[69]. A survey of residents in San Diego County, California, provided results indicating that self-efficacy had a positive indirect effect on the relationship between climate knowledge and pro-environmental behavior[70]. Efficacy beliefs have also been suggested to influence action among audiences differing in concern and engagement regarding climate change[71,72]. This research is consistent with psychological theory of the fundamental human needs guiding behavior, including people's need to believe in their ability to achieve their goals[37]. Given the potential broad applications of efficacy belief messaging, this approach may be of particular interest to ocean change communicators. However, the framing of the message may require careful consideration to prevent defensive avoidance among individuals who do not believe in climate change in the first place[73].

A second implication of these findings is that the threats of ocean change that are most visible to managers may not be most effective for public engagement. Our ocean acidification message could not shift any level of behavioral intention, and yet, ocean acidification is one of the more pressing climate threats facing the Oregon coast[46,47], where we conducted our survey. Extensive research by other scholars has shown that climate communication can be most effective when it targets people's pre-existing concerns and emphasizes co-benefits from climate action for other priorities they already care about, such as their family's safety or the security of their livelihood[10,74,75]. For instance, an experimental survey of California residents found that a place-based climate change message (i.e., the California drought) only showed a significant response from participants who were already concerned about climate change[76]. One of the less-concerned participants in that study reported in a follow-up interview that they have other things in their life to worry about more[77]. Our results present a critical tension: Coastal and marine conservation organizations may be motivated to engage the public in climate action based on their concerns about ocean threats, but to do this engagement effectively, they may need to focus less on their own concerns and more on those of the public. For instance, projected sea level rise along the Oregon coast will intensify coastal erosion and flooding, thereby degrading transportation routes and infrastructure, displacing up to 2116 individuals and causing an estimated $125 million in damages in the next 100 years[77]. Shifting the focus of communication to the immediate concerns of the audience could make taking action more salient, and tailoring the message to address people's fundamental motivations related to their sense of self could make taking action more likely[36,37].

A third implication of the messages in this experimental study is that a sample message reminding an audience of a place's natural beauty may be insufficient to affect people's deep-rooted identities and connections with a place (e.g., connectedness to the coast). The connectedness to the coast message had no substantial effect on relational organizing intention and could not predict actual feelings of connectedness to the coast. Recent literature has highlighted the strong interrelationships between a place's natural and social contexts, suggesting that place connection is manifested through both private enjoyment (e.g., esthetic beauty) and shared experiences with close others at the place[78]. Framing communication efforts to target the social context of attachment within the natural setting (e.g., the beach as a venue for bonding) might more effectively inspire people to engage in social and collective climate actions, such as relational organizing. Emphasizing social sense of place rather than environmental sense of place could also leverage people's deep-seated need to belong[37], which has been shown to inform people's climate beliefs, including policy support[79].

Still, place connection alone is not enough to instill action; instead, it could be used to enhance an already-effective message, such as one targeting efficacy beliefs. In a messaging experiment among Australian residents, messages that highlighted a relevant and iconic place (e.g., the Great Barrier Reef) strengthened participants' climate action intentions compared to generic control messages; however, messages emphasizing collective efficacy influenced uptake of a broader range of public-sphere behaviors[80]. Other research has shown that higher environmental self-identity is related to increased pro-environmental actions[81] and that social identity is an important predictor of collective actions[82]. Synthesizing these findings, connectedness to the coast may have potential uses for creating a collective "coastal identity." Future research could look at connectedness to place as a means for building shared community identity to increase collective efficacy and public-sphere climate actions.

This study's evidence that an efficacy-based message could increase behavioral intention in even a short intervention (roughly a 30 to 60-s message) exhibits the potential for efficacy to serve as an important target for persuasive interventions encouraging climate action. The small effects observed, however, could suggest that successfully engaging an audience through their efficacy beliefs may require more engaging, lengthier interventions.

Lengthier efficacy engagement strategies may strengthen the effects on climate action intentions and induce long-term effects by increasing the likelihood and extent to which the intervention actually targets their efficacy beliefs. An intervention's effectiveness is largely dependent on how well it matches the key determinants of the behavior of interest[83,84]; in this case, how well an intervention matches the efficacy beliefs contributing to a person's intention to engage in relational organizing. The effectiveness of interventions differing in intensity was observed in a second-order meta-analysis of 430 studies employing climate change mitigation interventions, in which the effectiveness of the overall interventions drastically reduced when specifically assessing large-scale (often short-term) interventions[85]. It may, therefore, be beneficial to design small-scale, lengthier engagement strategies that could more rigorously target participants' efficacy beliefs, particularly for influencing public-sphere actions such as relational organizing that are more socially complex. For instance, repetitive interventions that foster persistent practice in public-sphere action, such as climate change discussion groups[10] and climate stewardship programs[86], could enhance self-efficacy through the experience of mastery, thereby reinforcing engagement in the action[55].

The difficulty in long-term efforts, however, is the high level of voluntary participation and retention required for their success. The choice between large-scale, short-term interventions and small-scale, long-term interventions evokes tradeoffs between effectiveness and reach[85]. Large-scale interventions have the capacity for broader reach, but small-scale interventions tend to use more targeted approaches[85]. Ocean practitioners often only have a narrow window to reach people (for instance, as they enter a beach) and shift their actions on topics that matter for marine conservation but that may not necessarily matter to the audience (e.g., ocean acidification). Psychologically wise strategies strong enough to shift behavior in a short interaction or engaging enough to convince a person to stay for a longer intervention are both needed.

One potential strategy for strengthening the effect of a short-term intervention may be to show rather than tell. Visuals, such as photographs,

have the power to create stronger emotional and immediate cues and are more likely to be accepted compared to text[87]. The limited research applying visual framing to ocean conservation communication has shown effective in influencing pro-environmental attitudes and behavior. A recycling sign with a marine animal trapped in plastic debris reduced plastic waste by 17% in a high-rise office building in Vancouver, Canada[88]. In an online survey of Oregon residents, participants' emotions, norms, and attitudes became more negative as they were shown four images depicting deteriorating ocean conditions associated with ocean acidification[45]. However, that study did not measure if participants would take action in response to the images. Further research is needed to identify suitable psychological constructs for visual framing in specific contexts and understand the extent to which a visual approach, or any short messaging intervention, could influence climate action intentions.

Messaging intervention and other communications intended to build public engagement and influence attitudes and behaviors are vital for conservation programs and management agencies[34]. This study's experimental design was structured to have high ecological validity in that it mimicked on-the-ground (or rather, on-the-sand) outreach to coastal visitors. Therefore, the limitations faced here mirror real-life limitations faced by ocean communicators. For example, response biases common to field experiments, such as non-response bias (i.e., individuals avoiding participation due to the climate change topic) and social desirability bias (i.e., individuals overstate climate action intentions to appear favorable to the interviewer), could likewise translate to in-person outreach. Visitors may avoid climate change messaging altogether or provide positive but short-lived responses to appear agreeable. One of the key challenges in efforts to engage coastal visitors is the balance between detail and duration, as seen through the small increases in behavioral intention invoked by our short experimental messages. Further, our study was limited in its capacity to conduct an audience segmentation analysis prior to its experiment and relied on the presumed psychological beliefs of the coastal audience (e.g., connectedness to the coast). The messages may have benefited from explicit tailoring to different audiences within the broad group of coastal visitors. However, acknowledging that ocean change communicators are likely under similar constraints, tailoring to specific audiences is not a universally applicable solution. At times, it may not even be an option. Thus, there is still a need for strategies that work for broader known audiences such as coastal visitors.

A limitation in messaging research more broadly is the ability to measure messaging's effect on actual behavior. While we intended to confront this limitation with stickers as a proxy for real-life relational organizing, we detected no difference between conditions using this exploratory approach. The challenge of measuring communication's impacts on real-life and long-term behavior is a consistent problem for behavior change communication research, and behavioral intentions remain one of the most widely used constructs for related research[89]. Although research on intentions suggests they can be highly predictive of actual behavior[89], well-developed methods for measuring communications' effect on actual action are needed.

Conclusions

This study contributes to the relatively small but rapidly growing body of research on the potential of message framing for mobilizing action in response to ocean change. Our study highlights that the psychological constructs found to be strongly associated with action intention in correlative studies may not be predictive of action in robust experimental designs. Consideration of context-specific and audience-specific factors can further strengthen the use of these constructs. Still, our findings suggest that targeting behavior-specific efficacy beliefs in large-scale communication campaigns may help increase climate action. Our ability to detect an effect in a short-duration intervention also suggests longer-term interventions may be even more powerful. Message framing is unavoidable: whether intentional or unintentional, anytime a piece of information is communicated, it is framed. The most successful communicators frame their environmental messages informedly and strategically[13]. Continued research can support ocean communication strategies that may help turn the tides on ocean change.

Methods

Data collection

The experimental design and analysis plan for this study was preregistered on OSF (REDACTED FOR REVIEW). Data were obtained from questionnaires administered in person to visitors at 23 coastline access points along a 258-mile stretch of the Oregon coast over 10 weeks from June 22nd to August 22nd, 2023 (OSU IRB protocol #REDACTED FOR REVIEW). Sampling sites were chosen based on their visitation frequency and access criteria, adapted from sites used in a previous Oregon Department of Fish and Wildlife (ODFW) Marine Reserves visitor intercept survey[90]. "Visitors" in this study were considered anyone present at the coastline access points at the times of data collection, including both tourists and local residents. Pairwise power analysis using G*Power software showed that a total sample size of at least 1256 was needed for between-subjects analysis with 80% power of detecting a 6% change (or $d = 0.23$ effect size), assuming 5% of participants would be dropped from all rejection criteria. The sample sites were systematically rotated by time of day, day of the week, and location to control visitor characteristics relative to visiting day, time, and location[90]. During the 10-week sampling period, each site was sampled for 15 total hours. We approached every fourth visitor to the site. Groups were counted as one visitor; if the fourth visitor was a group, the person with the next birthday was selected to participate. Volunteers were not accepted to preserve the sampling design. If a visitor declined participation, the surveyor recorded their estimated age range, group size, the sample site, time, and their reason for declining to account for visitors who may be declining due to the questionnaire's content. Visitors who accepted participation self-completed the questionnaire by hand.

Our survey team approached an estimated 4327 visitors and received 2451 responses from eligible participants. After accounting for 12 questionnaires completed by ineligible participants (e.g., participants who were observed to collaborate with others in their group), our response rate was 56.8%. Precise totals for the number of visitors approached and the number of nonresponses are unavailable due to possibly missed nonresponses on logs during busier sampling days. The sample profile is provided in Supplementary Information. The equivalent materials questionnaire design was as follows: four questions on self-reported past climate actions, a short message on ocean change, an open-ended question on the participant's reaction to the message (i.e., manipulation check), six questions on future climate action intentions, eleven questions measuring the psychological constructs tested (i.e., connectedness to the coast, efficacy beliefs, and perceptions about ocean acidification), three questions on perceptions about Oregon's marine reserves, and four demographic questions (see supplementary information for questionnaire items). The questionnaires were designed to take no more than 4–5 min to complete to reduce respondent burden. After completing the questionnaire, participants were offered a choice of one of three stickers (two experimental and one control).

Four message conditions (three experimental and one control) were developed to measure the influence of message framing via a between-subjects experimental design (see supplementary information for message conditions). Each message was written at a ninth-grade reading level and consisted of one paragraph of text, six to eight sentences long, and took about thirty seconds to read. The experimental conditions targeted the specific psychological constructs being measured, specifically: (1) perceptions about ocean acidification as a proximal threat from climate change (condition 2); (2) connectedness to the coast (condition 3); and (3) relational organizing efficacy beliefs (condition 4). The standard control message (condition 1) explained the marine reserve system in Oregon and did not explicitly mention ocean acidification or the psychological constructs nor include a call to action. To strengthen the randomness of the experiment and ensure sample sizes across messages were relatively equal, we implemented a randomized block procedure for message conditions. A block size

of four was used with 24 possible balanced combinations of the order of conditions.

Measured variables

We measured four climate actions, each relating to a level of influence from Amel et al.'s[8] multilevel model of behavior change; specifically, one individual-level action, two interpersonal-level actions, and one community-level action. The individual-level action was "making food choices to reduce your carbon footprint." The interpersonal-level actions were "talking to others about the impacts of climate change on oceans" (i.e., interpersonal communication) and "encouraging others to get involved in climate action" (i.e., relational organizing). The community-level action was "participating in a community-organized climate activity."

We used six questions to measure these intended future climate actions in two ways: likelihood of engaging in these climate actions in the next 12 months and intended frequency of these climate actions in the next 12 months. Likelihood was only measured for the two interpersonal-level climate actions using a six-point scale where 1 = *extremely likely* and 6 = *extremely unlikely*, which was reverse coded for the analysis. Intended frequency of future climate action was measured for all four climate actions on a six-point scale from 1 = *at least once a day* to 6 = *I don't expect I will do this* and were also subsequently reverse coded for the analysis. Scores for relational organizing intended frequency and relational organizing intended likelihood were averaged to derive one relational organizing intention ("relational organizing intention") score for each participant (Cronbach's alpha = 0.79, $M = 3.4$, SD = 1.2). We did not combine interpersonal communication intended frequency and interpersonal communication intended likelihood due to the lower reliability of the combined variable (Cronbach's alpha = 0.64). A proxy for actual relational organizing action was measured through participants' sticker choice. Our control sticker was the Oregon Marine Reserves logo. Our two treatment stickers related to the intermediary psychological constructs measured, one with the phrase "Ocean change makes our mussels weaker" (Mussels sticker) and the second with the phrase "Let's turn the tides on ocean change" (Tides sticker). Self-reported past climate action questions reflected those of intended future frequency of climate action. Respondents were asked (pre-condition) how frequently they engaged in the four climate actions within the last 12 months. Responses were on a six-point scale where 1 = *Never* to 6 = *At least once a day*. Perceptions about ocean acidification were measured through a series of four questions adapted from Chryst et al.'s[91] Six Americas Super Short SurveY (SASSY). The questions measured personal importance of ocean acidification, concern about ocean acidification, personal risk perception of ocean acidification, and expected harm of ocean acidification to future generations of people. We re-scored the results of each variable using its standardized z-score to give all variables equal weight, allowing us to average them into an ocean acidification perceptions composite score for each participant (Cronbach's alpha = 0.80, $M = -0.01$, SD = 0.81).

Connectedness to the coast was examined using measures for sense of place similar to those used in previous studies[92,93]. Respondents were provided with three statements to rate their level of agreement or disagreement on a seven-point scale from 1 = *strongly disagree* to 7 = *strongly agree*. Each statement measured one of the three sense of place constructs—place attachment, place identity, and place dependence. Scores were averaged to derive one connectedness to the coast score for each participant (Cronbach's alpha = 0.84, $M = 5.8$, SD = 1.2).

Efficacy beliefs were measured with responses to four statements on a seven-point scale, where 1 = *strongly disagree* and 7 = *strongly agree*. Adapted from Nelson et al.[86], the statements measured self-efficacy, personal response efficacy, relational organizing efficacy, and relational organizing response efficacy. The four measures were averaged into one variable for overall efficacy belief (Cronbach's alpha = 0.86, $M = 4.4$, SD = 1.4). Self-assessed knowledge of Oregon's marine reserves was measured on a scale from 1 = *not* knowledgeable to 4 = *highly* knowledgeable. Opinion about the marine reserves was on a scale from 1 = *strongly* oppose to 5 = *strongly* support, with an additional option of *no opinion*. Geographic knowledge of the closest marine reserve was binary-coded (1 = correct response, 0 = incorrect response), with an additional option of *don't know*. Other variables included state/country of residence, age, gender, and highest level of education completed.

Data analysis

We analyzed the data using R version 4.2.3. After data cleaning and removing questionnaires that were one-third or more incomplete, the final sample size used in analyses was 2414 participants. Broken down by message condition, this sample includes 611 respondents for the control (condition 1), 606 respondents for the ocean acidification message (condition 2), 600 respondents for the connectedness to the coast message (condition 3), and 597 respondents for the relational organizing efficacy message (condition 4). Each analysis used a two-tailed test, and p values below 0.05 were considered significant. To compare the fully cleaned sample ($n = 2414$) to a sample that removed respondents who did not provide a response to the manipulation check or responded with "NA" ($n = 1970$), we ran unequal variance T-tests between the means of the four climate action outcome variables and found Am (Table S1). Following suggestions to avoid dropping subjects based on a manipulation check due to potential bias[94], we used the full sample for the analyses ($n = 2414$).

We tested our hypotheses in the linear regression model: Relational organizing intention ~ Message condition. The assumptions of linear regression were tested to ensure they were met by the model. We made pairwise comparisons with each experimental condition to the control (condition 1). Each experimental condition was coded as a dummy variable: ocean acidification condition dummy code (condition 1 = 0; condition 2 = 1; condition 3 = 0, condition 4 = 0), connectedness to the coast condition dummy code (condition 1 = 0; condition 2 = 0; condition 3 = 1, condition 4 = 0), relational organizing efficacy beliefs condition dummy code (condition 1 = 0; condition 2 = 0; condition 3 = 0, condition 4 = 1). As a secondary analysis of our hypotheses and to test a proxy for actual relational organizing, we performed a multinomial logistic regression of the message condition's effect on sticker choice.

We validated our marine reserves message as an a-theoretical control in two ways: (1) confirming participants' post-message perceptions of Oregon's marine reserves were similar across treatment conditions, and (2) confirming participants' post-message psychological construct scores were similar across the non-targeting conditions. To validate that experimental conditions targeted their intended psychological constructs, we conducted regressions between each message on its relevant construct. Specifically, we checked for associations of the ocean acidification message on perceptions about ocean acidification, the connectedness to the coast message on feelings of connectedness to the coast, and the relational organizing efficacy beliefs message on efficacy beliefs. As a post hoc sensitivity analysis, we performed additional regressions with relational organizing intended frequency as the dependent variable. We validated the impact of experimental conditions by controlling for respondents' relational organizing past frequency and demographics as covariates within the model. We did not measure respondents' self-reported past likelihood, which prevented us from running a similar post hoc analysis for behavioral likelihood.

To confirm the regression results in our main analyses, we ran additional exploratory ANOVA and t-tests among and between message conditions. We performed regression analyses to determine whether the experimental messages were significantly associated with an increase in other non-target behavioral intentions (i.e., individual climate action, interpersonal communication, and community action) relative to the control. We conducted a chi-square test between message condition and sticker choice as a post hoc sensitivity analysis to our secondary analysis.

Finally, we explored the potential effects of the psychological constructs on the relationships between their associated experimental conditions and relational organizing intended frequency. We performed simple mediation analyses following Hayes'[95] Macro Process via bootstrapping method. A mediation effect was considered if the following conditions were met: (1) there was an indirect effect of message condition on the outcome variable via

the psychological construct and (2) the 5000 bootstrap samples corrected the bias for a 95% confidence interval around the indirect effect. If the 95% confidence interval excluded zero, the indirect effect was considered statistically significant. All additional post hoc sensitivity and exploratory analyses results are described in the supplementary information.

Data Availability

The de-identified dataset generated and analyzed in the current study is made available in the OSF repository, https://osf.io/5g4k9/?view_only=2671e2d9f00142869e1d195f10624b1e.

Code availability

The underlying code for this study is publicly available in its OSF repository and can be accessed via this link (https://osf.io/5g4k9/?view_only=2671e2d9f00142869e1d195f10624b1e).

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Author contributions

M.S.J. and T.C.S. conceived the study idea. J.L.W., T.C.S., and M.S.J. designed the experiment and fieldwork protocols. J.L.W. collected and analyzed data. M.S.J. supervised the study, and T.C.S. substantially contributed to data collection supervision. J.L.W. and M.S.J. interpreted the results. J.L.W. drafted the manuscript, and all authors contributed to writing and editing.

Competing interests

J.L.W. and M.S.J. declare no financial or non-financial competing interests. The Oregon Department of Fish and Wildlife supported this project, and T.C.S. was employed by the Oregon Department of Fish and Wildlife during the bulk of the study.

Additional information

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