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How does goal framing effect influence household low-carbon behavior: The roles of environmental self-efficacy and global–local identity

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Introduction: Compared to carbon emission reduction from production, reduction from households is more required. This study explores the mechanism and boundary conditions of the effect of goal framing on household low-carbon behavior by drawing on the framing effect and social cognitive theory. The central questions posed in this research are whether, how, and under what circumstances goal framing affects household low-carbon behavior.

Methods: We tested the hypotheses in two studies. Study 1 investigated the main effect of whether the framing effect of climate change has a different influence on household low-carbon behavior. Study 2 further confirmed the main effect of this study and verified the mediating role of environmental self-efficacy and the moderating role of global–local identity.

Results: Across two experiments, we discovers: 1) Goal framing of climate change messages affects household low-carbon behavior. In particular, loss framing elicits a greater persuasive impact on household low-carbon behavior than gain framing. 2) Environmental self-efficacy plays a mediating role between the framing effect and household low-carbon behavior. Specifically, loss framing of climate change messages is more likely to increase residents' environmental self-efficacy than gain framing, which increases their household low-carbon behavior. 3) Residents' global-local identity moderates the effect of the framing messages on household low-carbon behavior. Among residents with a local identity, loss framing has a more powerful influence on household low-carbon behavior compared to gain framing. Among residents with a global identity, a significant difference between the effects of loss and gain framing on household low-carbon behavior is not found.

Discussion: The theoretical and managerial implications of the study are also discussed.

KEYWORDS

framing effect, environmental self-efficacy, global-local identity, household low-carbon behavior, mediating effect

1 Introduction

Scientists have a general consensus that global warming will result in serious consequences such as reduced food production, frequent extreme weather, and epidemic diseases (Mcmichael et al., 2006; Altizer et al., 2013; Springmann et al., 2016). In order to curb global warming, it is essential to control carbon emissions from human activities. Importantly, consumption-

relevant carbon emissions are an important source of greenhouse gases. Household carbon emission accounts for more than 50% of global carbon emissions (Druckman and Jackson, 2016; Jiang et al., 2020), especially in developing countries, and the proportion of household carbon emission is increasing year by year with the improvement of living conditions (Zhang et al., 2015; Du et al., 2021). Given the important impact of household carbon emissions on climate change, it is particularly necessary to explore the determinants of household proenvironmental behavior.

Previous research has mostly focused on the antecedents of proenvironmental behavior from both individual and situational perspectives. The former factors incorporate environmental emotions, environmental attitudes, values, ecological knowledge, face consciousness, and perceived severity (Chan and Lau, 2000; Schultz et al., 2005; Fraj and Martinez, 2007; Wang et al., 2019; Odou and Schill, 2020). In contrast, from the perspective of situational factors, some scholars investigated proenvironmental behavior based on air quality, participation in environmental actions, demographics, size of family, and social class (Wu and Geng, 2020; O'rourke and Macey, 2003; Dubois et al., 2019; Yan et al., 2021), among others. With the proliferation of research on the framing effect, extant research has introduced the framing effect into the domain of proenvironmental behavior study and confirmed its persuasiveness (Tversky and Kahneman, 1981; Levin et al., 1998; Levin et al., 2002; Jacobson et al., 2019; Li et al., 2021). However, there are three different kinds of framing effects (Levin et al., 1998), namely, risky choice framing, attribute framing, and goal framing. The aforementioned research has mostly investigated the antecedents of proenvironmental behavior in terms of either the first or the second framing (Mir et al., 2016; Brazil et al., 2019; Lagomarsino et al., 2020). Research on the effect of framed messages on proenvironmental behavior based on goal framing is limited. Moreover, as an important part of proenvironmental behavior, household low-carbon behavior often includes habit-based curtailment behavior and technology-based efficiency behavior (Jansson et al., 2010; Karlin et al., 2014; Choon et al., 2018), which is spontaneously implemented at home without effective regulation, distinguished from other proenvironmental behavior. The bulk of research focuses on the proenvironmental behavior outdoors (Jansson et al., 2010; Wiest et al., 2015; Mir et al., 2016; Jacobson et al., 2019). Nevertheless, the research on household low-carbon behavior, in particular in terms of goal framing, is relatively insufficient.

The central questions posed in this current research are whether, how, and under what circumstances goal framing affects household low-carbon behavior. First, because goal framing has a positive impact on the behavioral response and the negatively framed messages have more persuasiveness than the positively framed messages (Levin et al., 1998), we expect that loss framing has a more powerful impact on household low-carbon behavior, compared to gain framing. Second, prior research has revealed that the framing effect has a positive impact on exercise self-efficacy (Lim and Noh, 2017). In particular, Hornsey et al. (2015) found that participants who read a high-threat message reported more efficacy than those who read a climate change message that downplayed a threat. Helme-Guizon et al. (2021) stated that loss framing elicited higher levels of self-efficacy than gain framing in prevention messages. Moreover, based on the social cognitive theory (Bandura, 1982), self-efficacy has a significant predictive effect on individual behavior. Therefore, we predict that environmental self-efficacy plays a mediating role between the goal framing effect and household low-carbon behavior. Third, according to previous research (Gal and Rucker, 2018; Grazzini et al., 2018; Homar and Cvelbar, 2021), the effect of framing messages on individual behavior depends on a few situational conditions, but there has been limited research on the moderating role of residents' perceived identity, particularly for environmental behavior. By drawing on residents' perceived identity, this study introduces global–local identity (Arnett, 2002) into the relationship between goal framing and low-carbon behavior and posits that the interaction of residents' identity and framing effect will have an important impact on household low-carbon behavior.

In summary, first, this current research contributes to the literature on the antecedents to household low-carbon behavior to deepen our understanding of proenvironmental behavior. Second, we investigate the underlying mechanism between the framing effect and household low-carbon behavior to open the "black box" in the main nexus and broaden the application scenarios of self-efficacy. Finally, we reveal the boundary conditions of the effect of goal framing on household low-carbon behavior drawing on global–local identity. To our best knowledge, this is one of the first research on the moderating role of global–local identity in the context of household low-carbon behavior. However, our research can provide some guidelines for practically promoting household low-carbon behavior in the background of global warming.

The remainder of this study is organized as follows: first, we review extant relevant literature and present the conceptual foundations for the main, mediating, and moderating effects. Second, we test these hypotheses across two different studies. Then, we discuss the theoretical and managerial applications of the findings and point out the limitations of this current research and future research suggestions.

2 Conceptual background

2.1 Proenvironmental behavior and household low-carbon behavior

Under the background of climate change, scholars are increasingly concerned about the impacts of human behavior on the environment and focus more on proenvironmental behavior. Stern (2000) divided proenvironmental behavior into two basic types: environmental behavior in public and environmental behavior in private. Along this line of logic, Huang (2016) classified proenvironmental behavior into accommodating, promotional, and proactive behavior. Consistent with the concept of proenvironmental behavior in private, proposed by Stern, proactive behavior incorporates purchasing, maintenance, and recycling behavior. Proenvironmental behavior in public has been studied extensively, for example, supporting an environmental organization (Jacobson et al., 2019), transportation mode choice (Mir et al., 2016), private car use reduction, and new energy vehicles purchase (Jansson et al., 2010). In contrast, research on household low-carbon behavior is limited. Although one household's low-carbon behavior has an insignificant impact on global warming separately, its aggregated effects on the environment should not be underestimated in light of the whole society.

As an important part of proenvironmental behavior, household low-carbon behavior is the opposite of high-carbon behavior. In terms of carbon emission, household low-carbon behavior means that

residents take some measures on purpose to reduce greenhouse gas emissions in daily life in response to global warming. Researchers generally divide household low-carbon behavior into two types: habit-based curtailment behavior and technology-based efficiency behavior (Jansson et al., 2010; Karlin et al., 2014; Choon et al., 2018). The former tends to occur frequently in daily life, without money paid, such as turning off lights before leaving the house, which is often a habitual behavior in daily life that can cause inconvenience if changed. The latter tends to happen infrequently and requires a one-shot investment by residents, with relatively high costs, such as utilizing energy-efficient appliances and decorating the house with energy-efficient materials. In this way, residents often need to replace old inefficient technologies with new efficient ones that do not cause inconvenience or discomfort to themselves.

2.2 The effect of goal framing on household low-carbon behavior

Terminology framing is initially coined by the sociologist Goffman (1974). In the domain of management and organizational behavior, the framing effect is introduced by Tversky and Kahneman (1981). Using experimental methods, they found that when the same issue is presented in different ways, the recipients would have different understandings and thus make different choices. Drawing on the framing effect, scholars have investigated its impacts in different fields such as organizational management, health behavior, advertising and marketing, and public policies (Mark and Ron, 2014), generating a large number of valuable findings, in which some conclusions are sometimes conflicting. There is no unanimous conclusion as to whether loss or gain framing is more likely to motivate behavioral change (Do et al., 2021). Levin et al. (1998) attributed these variances to the phenomenon that researchers confuse the different framing types. They categorized framing effects into three basic types: risky choice framing, attribute framing, and goal framing. In risky choice framing, discrete choices between a risky and a riskless option of equal expected value depend on whether the options are described in positive (i.e., lives saved) or negative (i.e., lives lost) terms. In attribute framing, researchers manipulate only a single attribute of an object or event within any given context (i.e., "65% of the students have cheated during their college career" or "35% of the students have never cheated"). As for goal framing, the impact of persuasive messages depends on whether the messages stress either the positive consequences of performing an act or the negative consequences of not performing the act. The question in goal framing is which frame, positive or negative, has a greater persuasive impact on achieving the same end result. They pointed out that these three types of framing effects are not supposed to be treated equally; otherwise, research will lead to unwarranted comparisons that probably create unnecessary confusion. Scholars have studied the relationship between risky choice framing and attribute framing and proenvironmental behavior (Spence and Pidgeon, 2010; Freling et al., 2014; Mir et al., 2016; Brazil et al., 2019; Lagomarsino et al., 2020). Nevertheless, research on the effect of goal framing on household low-carbon behavior remains limited.

In terms of goal framing, the emphasis on the loss from not performing an act is more influential than the emphasis on the gain from performing the act (Levin et al., 1998). According to prospect theory (Kahneman and Tversky, 1979), individuals often make decisions with the inclination to loss aversion, and prospective loss has a greater impact on one's behavior than the equivalent gain. Consistent with this theory, extant research has found that loss frames are more effective in changing proenvironmental behavior (Hornsey et al., 2015; Poortinga and Whitaker, 2018; Amatulli et al., 2019; Shan et al., 2020; Helme-Guizon et al., 2021). Along this line of logic, faced with the loss messages of climate change of not performing a low-carbon behavior, residents can feel more negative consequences on the environment, individuals, and society (Wiest et al., 2015). Hence, we argue that loss framing messages of not implementing low-carbon behavior, which means carbon emission enhancement and subsequent global warming and more negative consequences, can have a greater impact on household low-carbon behavior than gain framing messages of implementing a low-carbon behavior, which will reduce carbon emission and thus mitigate global warming and result in positive impacts. Formally,

H1: The framing effect of climate change messages has a differential impact on household low-carbon behavior. Specifically, loss framing has a more powerful impact on household low-carbon behavior compared to gain framing.

2.3 Environmental self-efficacy: The mediating effect

According to the social cognitive theory (Bandura, 1982), self-efficacy is an individual's perception and expectation of their abilities and future outcomes, which affects behavioral performance. Environmental self-efficacy is referred to as an individual's belief in their ability to take action to mitigate climate change (Huang, 2016). In contrast to gain framing of climate change, loss framing presents people with negative consequences of climate change caused by not conducting low-carbon behavior, which makes residents feel more environmental risks. According to previous research (Levin et al., 1998), there is a negativity bias in processing information, wherein negative information has a systematically stronger impact on judgment than objectively equivalent positive information. Hornsey et al. (2015) stated that participants who read a high-threat message reported more efficacy than those who read a climate change message downplaying a threat. Grazzini et al. (2018) suggested that negatively framed messages have a more pronounced effect on hotel guests' recycling behavior *via* self-efficacy. Furthermore, based on the appraisal theory (Lazarus, 1966; Scherer, 1999; Keller et al., 2012), which is considered in terms of the specific cognitive and affective processes underlying environmental risk perception, the evaluation of an event or object affects an individual's emotions and behavioral tendencies. Thus, feeling more environmental risks can lead to more saliently negative environmental evaluation and consequential stronger environmental emotions. In addition, Amatulli et al. (2019) reported that negatively framed messages affect green purchase behavior through the mediating role of negative emotions, which can elicit remorse in consumers for failing to do what one ought or should do and activate consumers to alleviate this sense by adopting necessary behavior. Faced with surrounding risks, one individual takes advantage of control as a key psychological resource to eliminate or alleviate their impacts (Hornsey et al., 2015), which leads to a stronger intention to adopt household low-carbon behavior and gives rise to higher environmental self-efficacy. Therefore, we predict that the loss framing that emphasizes the

negative consequences of climate change can produce stronger residents' environmental self-efficacy.

Self-efficacy affects whether an individual will perform an act, the persistence of the act, and the effort level (Bandura, 1977). People with high self-efficacy believe they can perform a task, are willing to engage in it, and will put more effort into completing it; they are also willing to persist when encountering difficulties. Moreover, according to the value-belief-norm theory (Stern et al., 1995; Stern, 2000), one individual's belief influences their low-carbon behavior. Individuals with high environmental self-efficacy believe that their behavior can change the environment. Hence, their intentions to engage in a particular environmental behavior will be enhanced (Huang, 2016; Dermody et al., 2018). For example, Benjamin et al. (2017) confirmed that people with high self-efficacy are more likely to reduce their carbon footprints. White et al. (2011) verified that people with high environmental self-efficacy are more willing to conduct waste recycling behavior. We argue that residents with high environmental self-efficacy believe their low-carbon behavior can reduce carbon emissions and thus contribute to climate change mitigation and are willing to implement low-carbon behavior. Consequently, we suppose the following hypotheses:

H2: Environmental self-efficacy plays a mediating role in the framing effect of climate change on household low-carbon behavior. Specifically, loss framing is more likely to increase residents' environmental self-efficacy and, in turn, boost their low-carbon behavior compared to gain framing.

2.4 The moderating role: Global–local identity

An individual's traits have a significant effect on the framing effect (Cesario et al., 2013; Gerend and Shepherd, 2013; Chatterjee et al., 2014). As an important trait, global–local identity has received increasing attention in recent years and has been introduced into the research fields of brand management, resident behavior, marketing strategies, and donation behavior (Lin and Wang, 2016; Gao et al., 2017; Yang et al., 2019; Ng et al., 2021; Wang et al., 2021), among others. As for proenvironmental behavior, to the best of our knowledge, there is no research on household low-carbon behavior from the perspective of global–local identity. Arnett (2002) described a local identity as one that involves membership in the local community and traditions, whereas a global identity involves membership in world culture, seeing similarities rather than dissimilarities among people worldwide, and awareness of what is happening in other parts of the world. Under the background of globalization, one individual has either a global or local identity (Arnett, 2002). The psychological result of globalization is that people increasingly associate themselves with the rest of the world and see themselves as global citizens (Guo and Hong, 2018). At the same time, people are also members of their own communities and hence associate themselves with their hometowns or countries, giving rise to local citizenship. Although one person can have both identities simultaneously, one identity will still be dominant and thus has a greater impact on human behavior, depending on individual characteristics and specific situations (Ng et al., 2021). Research has indicated that consumers with a strong global identity have concerns about the environment because they can easily relate to one unifying global cause of protecting the planet's environment (Salnikova et al., 2022). In our context, a local identity activates residents' mental associations with people in the local community and climate change within their community, whereas a global identity activates associations with people around the world and climate change worldwide.

Faced with the persuasive messages of climate change, residents with a dominant global identity place great focus on how the world is one big place and everyone living in this world is connected (Ng and Basu, 2019). They are more aware of what is happening in the world and are more concerned with their behavioral impacts on the world. Events in other corners of the world seem close to them, with a sense of closeness that is "far away but close at hand." In other words, they might consider the consequences of climate change for close and remote locations and people equally important (Loy and Spence, 2020), relate themselves to climate change in other countries, and feel more negative consequences of climate change. At this time, gain framing and loss framing can generate higher environmental self-efficacy among residents, which in turn leads to their low-carbon behavior. Therefore, we argue that there is no significant difference between the effect of gain and loss framing on residents' low-carbon behavior.

In contrast, residents with a dominant local identity care more about what is happening in their own regions or countries and lack interest in what is happening worldwide. As is known to us, global climate change is caused by excessive carbon emissions from human activities worldwide, and the issues of climate change can affect all humankind. As residents with a local identity pay less attention to worldwide climate change, they feel fewer negative consequences of global climate change. Thus, they will perceive the risks of climate change at a low level and will not feel personally responsible toward the environment (Krishnamurthy et al., 2001). Therefore, compared to gain framing, loss framing is more likely to deepen the understanding of negative consequences, and accordingly, environmental self-efficacy will be enhanced, leading to household low-carbon behavior. Formally,

H3: Global–local identity plays a moderating role in the influence of framing effect on low-carbon behavior. Specifically, when residents' global identity predominates, there is no difference in the effect of loss framing and gain framing on low-carbon behavior. When the local identity predominates, loss framing of climate change generates more adoptions of low-carbon behavior compared to gain framing.

The theoretical model of this current research is shown in Figure 1.

3 Overview of studies

The methodology of scenario experiment studies consists of presenting participants with carefully constructed and realistic scenarios to assess dependent variables, including intentions, attitudes, and behavior, thereby enhancing experimental realism and allowing researchers to manipulate and control independent variables (Aguinis and Bradley, 2014). By considering its convenience, accessibility, and validity, this method is suitable for this research. We tested the aforementioned hypotheses in two studies. Study 1 investigated the main effect of whether the framing effect of climate change has a different influence on household low-carbon behavior. Study 2 further confirmed the main effect of this study and verified the mediating role of environmental self-efficacy and the moderating role of global–local identity.

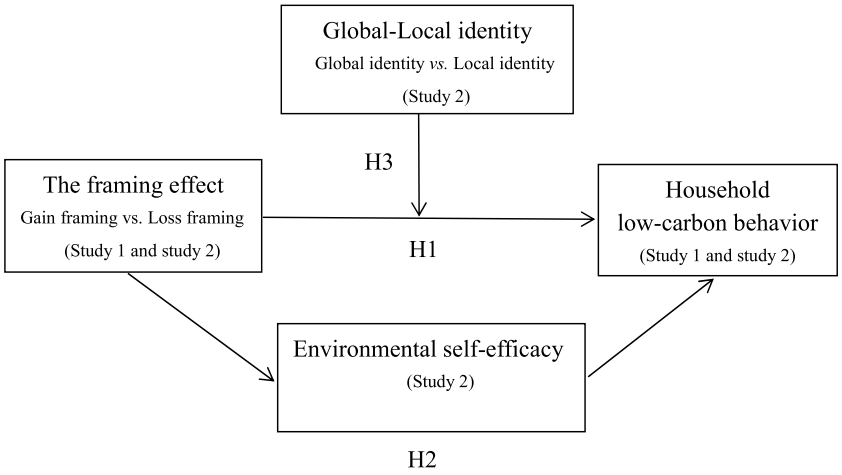

FIGURE 1
Theoretical model of the main effect, the underlying mechanism, and the moderating role of global–local identity.

3.1 Study 1

3.1.1 Pilot study

3.1.1.1 Methodology

Sixty-nine participants (42.03% female participants; M_{age} = 23.76, SD = 2.63) were recruited from one university in East China in exchange for non-compulsory credits and randomly assigned to the gain framing group (36 participants) and the loss framing group (33 participants). We manipulated the goal framing effect using an adjusted environmental campaign material (Spence and Pidgeon, 2010), designed to promote household low-carbon behavior. After reading the material, subjects were asked to complete manipulation and realism tests. As a dependent variable, household low-carbon behavior was measured on a 7-point Likert scale (1, strongly disagree; 7, strongly agree).

The material adopted in the manipulation for Study 1 is as follows:

Imagine you are attending an environmental campaign to reduce carbon emissions at home on World Environment Day. You are now reading the poster.

3.1.1.1.1 Gain framing of climate change. Excessive greenhouse gas emission is causing global warming. Carbon emission from households is increasingly becoming an important source of greenhouse gases. It is obviously beneficial to implement household low-carbon behavior to reduce carbon emissions for global climate:

- Prevent further increases in winter floods in maritime regions.
- Prevent further significant warming.
- Prevent further sea-level rises and thus prevent the inland migration of beaches and save up to 20% of coastal wetlands, maintaining the habitat availability for several species that breed or forage in low-lying coastal areas.
- Defend against reaching certain tipping points for significant key events. The safeguarding of the North Atlantic Thermohaline Circulation, the West Antarctic Ice Sheet, and the Greenland Ice Sheet has enormous effects on temperature and sea level.

In light of its positive impacts on climate change, please start your household low-carbon behavior from now on!

3.1.1.1.2 Loss framing of climate change. Excessive greenhouse gas emission is causing global warming. Carbon emission from households is increasingly becoming an important source of greenhouse gas. It is obviously detrimental not to implement household low-carbon behavior, leading to more carbon emissions for global climate:

- Result in further increases in winter floods in maritime regions.
- Result in further significant warming.
- Result in further sea-level rises and thus cause the inland migration of beaches and waste up to 20% of coastal wetlands, destroying the habitat availability for several species that breed or forage in low-lying coastal areas.
- Accelerate reaching certain tipping points for significant key events. The safeguarding of the North Atlantic Thermohaline Circulation, the West Antarctic Ice Sheet, and the Greenland Ice Sheet has enormous effects on temperature and sea level.

In light of its negative impacts on climate change, please start your household low-carbon behavior from now on!

We conducted a manipulation check for the framing effect using two items from Spence and Pidgeon (2010), asking participants about the extent to which information stresses gains or losses associated with climate change. In addition, we conducted a realism check for the goal framing effect using two items (Wu et al., 2015): "How realistic is the scenario?" (1, not realistic at all; 7, very realistic) and "How easy is it for you to imagine yourself in the scenario?" (1, very difficult; 7, very easy).

The scale developed by Karlin et al. (2014), with some appropriate adjustments to the current research, was used to measure the household low-carbon behavior of residents. We adopted three items to measure curtailment behavior: "I turn off the lights when leaving the room," "I use the washing machine only when clothes in it reach a certain amount," and "I turn off home appliances when I go to bed at night." With regard to efficiency behavior, the items include "I will consider adding insulation materials when decorating my house," "I will buy energy-efficient household appliances," and "I will replace old appliances with energy-efficient ones."

TABLE 1 Reliability and validity of a scale.

Scale	Cronbach's alpha coefficient	KMO	Bartlett's spherical test	Cumulative variance (%)
HLCB	0.85	0.86	391.26***	67.73

Note: HLCB represents household low-carbon behavior; *** represents $p < 0.001$.

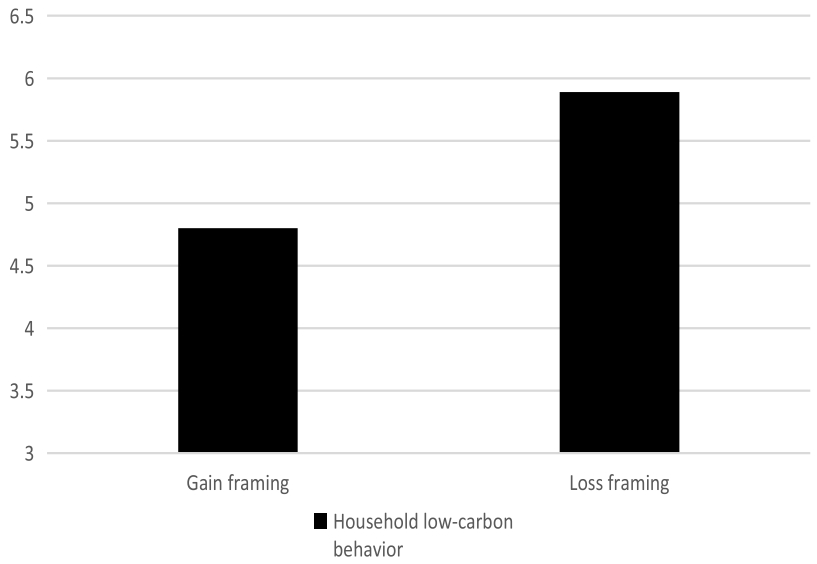

FIGURE 2
Effect of gain and loss framing on household low-carbon behavior.

3.1.1.2 Results

A preliminary normality test was conducted to see if the data were normally distributed before a *t*-test. The sample passed the Shapiro–Wilk test for normality with a *p*-value greater than 0.05. Then, we conducted a one-sample *t*-test to test the effectiveness of the framing manipulation and the realism check. The results indicated that for gain framing messages, $M_{gain} = 5.29$, $t = 33.61$, $p < 0.001$; for loss framing, $M_{loss} = 5.59$, $t = 23.54$, $p < 0.001$, and the mean values of two groups were higher than four. As for the realism check, $M_{realism} = 5.89$, $t = 79.11$, $p < 0.001$. Consequently, the manipulation materials passed the tests and could be used in the main study.

Reliability analysis of the scale of household low-carbon behavior revealed that (see Table 1) Cronbach's alpha coefficient is 0.85, higher than 0.7, indicating this scale has good reliability. The KMO value of the scale is 0.86, with $p < 0.001$, indicating the variable is suitable for factor analysis, and the cumulative variance contribution rate is 67.73%, indicating the scale validity is acceptable.

3.1.2 Main study

3.1.2.1 Methodology

We tested the main effect using a single factor between-subject design with two levels (gain framing × loss framing). One hundred and eighty-six undergraduate students were recruited from the same university in several classes in the main study in exchange for non-compulsory credits. Participants were first randomly assigned to two groups and read the gain framing messages (100 participants) and the loss framing messages (86 participants), respectively. In the attention check, 12 students who made incorrect choices were removed from the data, leaving a sample of 174 students for the analyses (46.6% female students; $M_{age} = 21.95$, SD = 3.12). After reading the campaign material, they reported their low-carbon behavior at home on six items used in the pilot study.

3.1.2.2 Results

The sample also passed the Shapiro–Wilk test for normality. We tested the effect of gain framing and loss framing of climate change on low-carbon behavior through an independent sample *t*-test using SPSS. The results demonstrated (see Figure 2) that the loss framing messages of climate change have a more positive effect on household low-carbon behavior than gain framing of climate change ($M_{gain} = 4.80$, $M_{loss} = 5.89$, $F = 4.32$, $p < 0.001$). Therefore, Hypothesis 1 was supported.

3.1.3 Follow-up study

We conducted a follow-up study to test the generalizability of our hypothesis in Study 1 in China. A total of 187 residents in a residential area were randomly recruited, and each one was paid RMB 8 for completing the experiment; 31 participants were dropped owing to failure to pass the attention check; and finally, 156 participants' data were analyzed (46.79% female participants; $M_{age} = 38.29$, SD = 10.51). Results showed that the subjects in loss framing messages ($N = 77$) reported more household low-carbon behavior than in gain framing messages ($N = 79$), $M_{gain} = 4.99$, $M_{loss} = 5.77$, $F = 0.02$, $p < 0.001$. The results of this follow-up study replicated the findings of Study 1 and demonstrated that the effect of framed messages on house low-carbon behavior is existent.

3.2 Study 2

3.2.1 Pilot study

3.2.1.1 Methodology

Eighty-nine undergraduate students from another university in East China were recruited in a pilot study in exchange for non-compulsory credits (47.19% female students; M_{age} = 21.25, SD = 2.89). We primed the subjects' global–local identity with the reading material selected from previous literature (Gao et al., 2017; Yang et al., 2019). After priming residents' identity perceptions, we manipulated the framing effect of climate change using new reading materials from the perspective of global energy waste to further validate the existence of the framing effect. Similarly, manipulation and realism checks were conducted on individuals' global–local identity and the framing effect of climate change. Finally, participants were asked to fill in the scales of environmental self-efficacy (Huang, 2016) and household low-carbon behavior (Karlin et al., 2014) in sequence, measured on a Likert scale with endpoints 1 representing "strongly disagree" and 7 representing "strongly agree."

The global–local identity operationalization was as follows (two materials were presented side by side on the same page).

3.2.1.1.1 Think Global Movement. We are promoting Think Global Movement, which encourages people to take a global perspective on our daily life. By signing your name below, you are showing support for our Think Global Movement.

Specifically, Think Global means you identify with the following behavior:

- You belong to the whole world.
- You are a global citizen.
- You always think globally.
- You hold a global viewpoint.
- You care about knowing global news.
- Your heart belongs to the whole world.
- You believe you are connected with the rest of the world.

Our Think Global Movement needs your support. Your support means everything to us.

3.2.1.1.2 Think Local Movement. We are promoting Think Local Movement, which encourages people to take a local perspective on our daily life. By signing your name below, you are showing support for our Think Local Movement.

Specifically, Think Local means you identify with the following behavior:

- You belong to the local community.
- You are a local citizen.
- You always think locally.
- You hold a local viewpoint.
- You respect your local traditions.
- You care about knowing local events.
- Your heart belongs to your local community.

Our Think Local Movement needs your support! Your support means everything to us.

The effectiveness of identity manipulation was measured on three items used in past research: "For the time being, I mainly identify myself as a. . .," "At this moment, I feel I am a. . .," "On top of my mind right now are thoughts of being a. . .." The Likert scale was used with endpoints 1 = global citizen and 7 = local citizen.

We manipulated the framing effect of climate change with new communication materials, as follows.

Imagine you are attending an environmental campaign to reduce carbon emissions at home on World Environment Day. You are now reading the poster.

3.2.1.1.3 Gain framing of climate change. Direct and indirect carbon emissions from households are an important source of greenhouse gases, causing global warming. Since the production and use of household energy, such as electricity and water, can emit great amounts of carbon, we should perform a low-carbon act and reduce energy waste at home, which will lead to beneficial results:

- Globally, we can save at least 2.8 billion kW of electricity each year.
- Globally, we can save at least 100 million m^3 of water each year.
- Globally, temperature rise will accordingly slow down and bring a series of positive environmental consequences.

Please start with yourself and reduce carbon emissions in life.

3.2.1.1.4 Loss framing of climate change. Direct and indirect carbon emissions from households are an important source of greenhouse gases, causing global warming. The production and use of household energy, such as electricity and water, can emit great amounts of carbon. If we do not perform a low-carbon act and consume unnecessary energy at home, it will lead to detrimental results:

- Globally, we can waste at least 2.8 billion kW of electricity each year.
- Globally, we can waste at least 100 million m^3 of water each year.
- Globally, temperature rise will accordingly accelerate and bring a series of negative environmental consequences.

Please start with yourself and reduce carbon emissions in life.

The manipulation and realism checks of the framing effect of climate change were conducted using the same items in Study 1. After reading the aforementioned materials, participants reported their environmental self-efficacy on four items ("As long as actions are taken to mitigate global warming, climate change can be effectively reduced," "I believe I have the ability to take action to mitigate global warming and prevent climate change" "Although it may cause inconvenience, I can still change my behavior to mitigate global warming," and "I can try my best in every way to mitigate global warming"). Finally, household low-carbon behavior was measured using the same scale in Study 1.

3.2.1.2 Results

The Shapiro–Wilk test for normality showed that data are normally distributed, and a one-sample *t*-test of the global–local identity is feasible. Results showed that the mean score of subjects with a global identity was 2.53, $t = 23.91$, $p < 0.001$, and the mean score of subjects with a local identity was 5.54, $t = 26.44$, $p < 0.001$. Thus, global–local identity manipulation was successful.

Then, a one-sample *t*-test was conducted for the manipulation of the framing effect of climate change. The results showed in gain

TABLE 2 Reliability and validity of scales.

Scale	Cronbach's alpha coefficient	KMO	Bartlett's spherical test	Cumulative variance (%)
ESE	0.89	0.77	202.99***	74.59
HLCB	0.86	0.81	288.84***	69.46

Note: ESE represents environmental self-efficacy; HLCB represents household low-carbon behavior; *** represents $p < 0.001$.

framing that $M_{gain} = 5.64$, $t = 33.31$, $p < 0.001$. In loss framing, $M_{loss} = 5.42$, $t = 21.58$, $p < 0.001$. With the same method in Study 1, the score of the realism check was 5.40, $t = 46.61$, $p < 0.001$. Therefore, the aforementioned materials of the identity perceptions and the framing effect could be used in the main experiment.

Reliability analyses of the scales of environmental self-efficacy and low-carbon behavior (see Table 2) showed that Cronbach's alpha coefficient of environmental self-efficacy was 0.89, the KMO value was 0.77, the *p*-value of Bartlett's spherical test was less than 0.001; Cronbach's alpha coefficient of the dependent variable was 0.86, the KMO value was 0.81, and $p < 0.001$ for Bartlett's spherical test, indicating the two variables are suitable for factor analysis. The results demonstrated that the scales had good validity with cumulative variance contribution rates of 74.59% and 69.46%, respectively.

3.2.2 Main study

3.2.2.1 Methodology

Two hundred seventy-nine undergraduate students participated in the study in exchange for non-compulsory credits (57.35% female students; $M_{age} = 23.32$, SD = 3.02). The main study employed a 2 (global identity *vs.* local identity) × 2 (gain framing *vs.* loss framing) between-subject design. The subjects first read the same stimulus materials to prime the global–local identity. After 5 min, participants read the framing messages of climate change. Finally, they reported their household low-carbon behavior and environmental self-efficacy using the scales in the pilot study. An attention check was incorporated into the study. In addition, extant research shows that gender, age, education, and family income impact proenvironmental behavior (Hunter et al., 2004; Botetzagias et al., 2014; Du and Zhang, 2020). We control for these demographic variables in the current study.

3.2.2.2 Results

Eighteen students who failed the attention check were eliminated from the data, leaving a sample of 261 students for the analyses (59.00% female students; $M_{age} = 23.15$, SD = 3.17). The effect of the framed messages of climate change on household low-carbon behavior was further tested. Likewise, we first implemented a Shapiro–Wilk test for normality, with $p > 0.05$. As for multicollinearity, VIF for each variable was not greater than 5, indicating that multicollinearity is conventionally acceptable.

Next, an independent sample *t*-test was conducted, showing that the loss framing of climate change has a greater effect on household low-carbon behavior compared to the gain framing effect ($M_{loss} = 5.94$, $M_{gain} = 5.04$, $F = 4.79$, $p < 0.001$), consistent with the conclusion in Study 1.

We then tested whether environmental self-efficacy drives the effect of framing messages on household low-carbon behavior in a mediation analysis with 5,000 bootstrap samples in the PROCESS program, based on Model 4. The correlation analysis showed that the framing effect is positively associated with household low-carbon behavior ($r = 0.47$, $p < 0.01$), with environmental self-efficacy ($r = 0.57$, $p < 0.01$), and environmental self-efficacy is positively associated with household low-carbon behavior ($r = 0.78$, $p < 0.01$). The analysis with the framing effect as the independent variable, environmental self-efficacy as the mediating variable, and household low-carbon behavior as the dependent variable showed that the mediating role of environmental self-efficacy is significant ($b = 0.20$, SE = 0.05, 95% CI: 0.10, 0.31), and the proportion of the mediating effect to the total effect was 32.62%, so H2 was supported (see Tables 3, 4).

Furthermore, we conducted a Sobel test for mediation, indicating that environmental self-efficacy can mediate the relationship between the framing effect and household low-carbon behavior indirectly, as depicted in the analysis by $p < 0.001$, indicating that H2 is accepted.

The effects of framing messages and global–local identity on residents' low-carbon behavior were examined by ANOVA, with the framing effect as the independent variable, the global–local identity as the moderating variable, and low-carbon behavior as the dependent variable. The results revealed that the interaction term of the framing messages and global–local identity has a significant effect on low-carbon behavior [$F(1, 253) = 65.43$, $p < 0.001$], indicating that the global–local identity moderates the relationship between the framing effect and low-carbon behavior. Independent sample *t*-test further showed that the effect of the loss framing on low-carbon behavior ($M_{loss} = 5.90$, SD = 0.63) was significantly higher ($t = -9.92$, $p < 0.001$) than the effect of gain framing ($M_{gain} = 4.62$, SD = 0.71) when local identity is dominant. In contrast, when global identity was dominant, the effect of framing messages on low-carbon behavior ($M_{gain} = 5.85$, SD = 0.24; $M_{loss} = 5.97$,

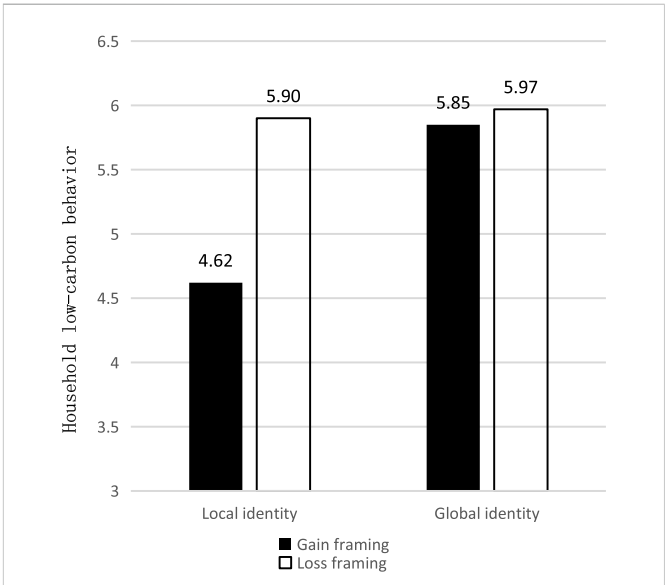

FIGURE 3
Moderating role of global–local identity.

TABLE 3 Check for the mediating role.

Variable	HLCB		ESE		HLCB	
	B	T	b	t	B	T
GLF	0.61	6.83***	0.49	4.35***	0.41	5.16
ESE					0.41	9.53***
R^2		.19		0.08		.40
F		11.77***		4.39***		28.40***

Note: GLF represents gain and loss framing; ESE represents environmental self-efficacy; HLCB represents household low-carbon behavior; *** represents $p < 0.001$.

TABLE 4 Analyses of the direct and indirect effects.

Effect type	Effect value	Boot SD	Boot 95% CI		Comparative effect (%)
			Upper limit	Lower limit	
Total effect	0.61	0.09	0.43	0.79	
Direct effect	0.41	0.08	0.25	0.57	67.38
Indirect effect	0.20	0.05	0.10	0.31	32.62

Note: Bootstrap resampling = 5,000; CI, confidence interval.

SD = 0.69) was not significantly different (t = −1.45, $p > 0.05$) (see Figure 3). Therefore, global–local identity moderates H3 was supported.

We once again investigated the moderating effect of global–local identity with 5,000 bootstrap samples in the PROCESS program based on Model 1. The analysis with the framing effect as the independent variable, the global–local identity as the moderating variable, and environmental self-efficacy as the dependent variable showed that the moderating effect of global–local identity is significant. Specifically, when residents have local citizenship, the confidence interval does not include 0 ($b = 0.90$, SE = 0.17, 95% CI: 0.57, 1.23). When residents have global citizenship, the confidence interval includes 0 ($b = 0.19$, SE = 0.14, 95% CI: −0.09, 0.46). Therefore, H3 was proved again.

4 General discussion

This current research confirms the existence of the goal framing effect of climate change in communicating household low-carbon behavior across two studies. With Study 1, we find that compared to gain framing, loss framing of climate change is more effective for household low-carbon behavior. The results replicate those of previous studies (Hornsey et al., 2015; Poortinga and Whitaker, 2018; Amatulli et al., 2019; Shan et al., 2020; Helme-Guizon et al., 2021), finding the main effect of goal framing on household low-carbon behavior, and echo the prospect theory (Kahneman and Tversky, 1979). In reality, this behavior is distinct from other kinds of proenvironmental behavior, which is spontaneously implemented at home without effective regulation. Our research sheds some light on the nexus between goal framing and household low-carbon behavior and deepens our understanding of this proenvironmental behavior (Jacobson et al., 2019; Homar and Cvelbar, 2021). Furthermore, we conducted Study 2 based on Study 1 to know how the framing massages influence household low-carbon behavior. In particular, loss framing enhances residents' environmental self-efficacy more effectively, which in turn leads to low-carbon behavior compared to gain framing. In particular, we elucidate the mediating effect drawing on appraisal theory in that loss messages of climate change can elicit individuals' stronger emotions and drive individuals' more psychological resources to control the negative consequences, which can enhance self-efficacy more effectively. Our findings are consistent with the extant literature about self-efficacy (Huang, 2016; Dermody et al., 2018). In addition, the framing effect works in some particular boundary conditions. Previous research has investigated these conditions from construal level, uncertainty, and involvement, among others (Cheng and Wu, 2010; Grazzini et al., 2018; Homar and Cvelbar, 2021). Differently, we investigated the moderator in terms of global–local identity under the current background of globalization. We introduced the global–local identity into our theoretical model and reported its moderating role in the main effect. In particular, when local identity predominates, the loss messages of climate change have a more effective influence on household low-carbon behavior, and when global identity predominates for residents, the framing effect of climate change disappears on household low-carbon behavior.

5 Conclusion and implications

5.1 Conclusion

Overall, the results support all the proposed hypotheses in this study. The reported data provide experimental evidence for the link between the effect of goal framing and low-carbon behavior. Consistent with the prospect theory, loss framing has a more powerful impact on household low-carbon behavior than gain framing. Meanwhile, the mediating role of environmental self-efficacy between the goal framing effect and household low-carbon behavior is supported. Third, drawing on residents' perceived identity, this study introduces global–local identity into the relationship between goal framing and low-carbon behavior and finds that the interaction of residents' identity and framing effect has an important impact on household low-carbon behavior. This study provides a

theoretical basis for further study of low-carbon behavior and some practical guidance for practitioners.

5.2 Implications

5.2.1 Theoretical implications

The current research provides several theoretical implications. First, it examines the understudied impact of goal framing on household low-carbon behavior. The framing effect, as an important persuasive mechanism, has been verified in marketing, healthcare, proenvironmental behavior, and public communication, among others. Although previous research has offered valuable insights into risky choice framing and attribute framing, the research is limited with regard to the effect of goal framing. Considering that carbon emissions from households account for a large percentage of greenhouse gas emissions, it is essential to investigate the effect of goal framing on household low-carbon behavior. The current research concludes that loss framing of climate change is more effective for household low-carbon behavior in environmental communication, which focuses on strategic messaging to mobilize the masses to engage in proenvironmental behavior (Liang et al., 2018). This finding enriches the research on the goal framing effect and low-carbon behavior, advances our understanding of the antecedents of household low-carbon behavior, and provides valuable references for promoting research on household low-carbon behavior.

Second, based on social cognitive theory (Bandura, 1982), this current study contributes to research on environmental self-efficacy and elucidates how the goal framing effect influences household low-carbon behavior, opening the "black box" of the relationship between the goal framing effect and low-carbon behavior. In particular, this study indicates that loss framing has a greater effect on environmental self-efficacy than gain framing and, in turn, motivates household low-carbon behavior. Meanwhile, previous research has demonstrated that self-efficacy can predict physical exercise (Lim and Noh, 2017), organizational behavior (Gist, 1987), online behavior (Eastin and LaRose, 2000; Kim et al., 2020), and knowledge sharing (Cheung and Lee, 2007), among others. The current study further expands the application domains of self-efficacy, demonstrating the predictive power of environmental self-efficacy on proenvironmental behavior.

Finally, extant research has valuable insights into the boundary conditions of the framing effect on proenvironmental behavior from the perspective of egoistic values (Lagomarsino et al., 2020), uncertainty avoidance (Chatterjee et al., 2014), self-relevance (Loy and Spence, 2020), warning messages and personal involvement (Du and Zhang, 2020), concern about global climate change (Newman et al., 2012), and partisan inclination (Wiest et al., 2015; Benjamin et al., 2017; Feldman and Hart, 2018), among others. However, the effect of an individual's global–local identity on the goal framing effect has not been verified. The global–local identity has a significant effect on individual behavior (Gao et al., 2017; Yang et al., 2019; Ng et al., 2021; Wang et al., 2021). This study introduces this variable into the theoretical model and confirms its effect on the framing messages, expanding our understanding of the boundary conditions of the framing effect and further broadening the application scopes of the global–local identity. To the best of our knowledge, this is the first time to introduce the global–local identity into the research on the relationship between the framing effect and household low-carbon behavior.

5.2.2 Managerial implications

The current research shows that communities, non-government organizations, and authorities can benefit from the loss framing messages of climate change to enhance persuasive effectiveness when communicating proenvironmental behavior. Particularly, they should highlight the negative influences of household carbon emissions on human beings, such as reduced food production, frequent extreme weather, and epidemic diseases, to promote proenvironmental behavior, especially household low-carbon behavior. From the perspective of public policies, it is also an effective green nudge (Schubert, 2017) for individuals and households to emphasize the aforementioned negative consequences, a low-cost and non-intrusive policy option for motivating green behavior (Homar and Cvelbar, 2021).

Second, this research confirms that environmental self-efficacy can predict household low-carbon behavior. Extant research indicates that emotions, knowledge, and skills are antecedent variables of self-efficacy (Bandura, 1999; Safari et al., 2020). By focusing on negative environmental messages, managers can arouse more environmental emotions in residents. At the same time, practitioners can take necessary measures to provide feedback on household energy outcomes (Karlin et al., 2014). Communities and relevant organizations can also train residents to develop their knowledge to save energy, especially action-based knowledge and effectiveness knowledge about climate change (Milfont, 2012), in order to contribute to household energy reduction.

Last but not least, the current research highlights the moderator of residents' global–local identity. There is no significant difference between the effects of gain and loss framing for residents whose global identity predominates. Communities and relevant organizations can choose either gain or loss framing of climate change to promote household low-carbon behavior. However, for those whose local identity is predominant, practitioners can highlight the negative consequences of not performing a low-carbon act because loss framing has a greater impact on low-carbon behavior in this boundary condition.

6 Limitations and future research

This research has some limitations. First, we investigated the effect of framing messages on household low-carbon behavior across two scenario experiments. Although the manipulation and realism tests were passed, the participants were not asked to perform low-carbon tasks in a real-life setting. Future research can further confirm our conclusions with real behavioral measures. Second, we used short-term data to verify three research hypotheses. However, behavioral changes often stem from internal and external influences in the long run, and the stability needs to be tested over a long period of time. Therefore, one longitudinal study is demanded in the future.

Another limitation of this current research is that we examine household low-carbon behavior from the perspective of the framing effect. However, in reality, household low-carbon behavior may be influenced by individual and organizational factors, namely, cross-

level factors (Zientara and Zamojska, 2018). Therefore, it is necessary to further explore the antecedent variables of household low-carbon behavior in terms of cross-level analysis to differentiate their impacts.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

HL and LW contributed to the conception and design of the study. YO and LZ organized the database and performed the statistical analysis. HL wrote the first draft of the manuscript. All authors contributed to the manuscript revision and read and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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