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Effectiveness of message framing in changing restaurant diners' plant-based meat consumption

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EFFECTIVENESS OF MESSAGE FRAMING IN CHANGING RESTAURANT DINERS' PLANT-BASED MEAT CONSUMPTION

Research highlights

- Message framing can foster restaurant diners' plant-based meat consumption
- A micro-longitudinal design is adopted to understand diners' decision-makings
- Health benefits of plant-based meats should be gain-framed abstractly
- Environmental benefits of plant-based meats should be loss-framed concretely

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Abstract

Drawing on regulatory fit theory, construal level theory, and means-end theory, this research examined the effects of message framing, message information, and message description on restaurant diners' consumption intentions (CI) and the amount they would be willing to pay more ($WTP) for a plant-based diet. The study employed a mixed between-within-group methodology with a micro-longitudinal 2 (gain vs. loss framing) × 2 (health vs. environment information) × 2 (attribute-based vs. benefit-based description) scenario-based experimental design. An analysis of 361 survey responses revealed that health information should be conveyed through gain-framed messages with benefit-based descriptions, whereas environment information should be conveyed through loss-framed messages with attribute-based descriptions. These results enriched our understanding of diners' attitudes towards plant-based meat consumption. Findings laid a theoretical foundation for future studies and present practical implications for the hospitality industry.

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1. Introduction

The food sector accounts for more than 30% of the world's greenhouse gas emissions (Vermeulen, Campbell, & Ingram, 2012). Farm animals require extensive natural resources that deplete water, intensify climate change, and reduce biodiversity. In particular, meat consumption poses a significant concern due to the extensive livestock population contributing to water depletion, aggravating climate change, upsetting the phosphorus cycle, and negatively affecting both the nitrogen cycle and biodiversity (Steinfeld et al., 2006). Additionally, the raising of livestock, particularly the intensification of animal farming practices, gives rise to concerns about the welfare of farm animals among consumers (Norwood & Lusk, 2011).

Although meat is an excellent source of protein, other nutrients, and calories in human diets, it, especially red meat, contains ingredients (e.g., heme iron, saturated fat, and carcinogens) that have been linked to heart disease and cancer (Pan et al., 2012). Springmann et al. (2016) estimated that meat consumption increases the global mortality rate by 6% to 10%. Perhaps unsurprisingly, scientists have begun pursuing the development of plant-based meat alternatives. By definition, plant-based meats, such as Impossible Burger™ and Lightlife™ Burger, are plant-based products that mimic the appearance, flavor and fibrous texture of animal meats (Boukid, 2021). Gordon et al. (2019) predicted that the global market for plant-based meat alternatives would experience a swift rise from USD$4.6 billion in 2018 to USD$85 billion in 2030.

Despite the growth of plant-based meat alternatives in the global market, the absolute number of consumers remains relatively small. A literature review conducted by He et al. (2020) summarized several barriers obstructing plant-based meat consumption: a taste barrier (the enjoyment of eating meat), a health barrier (perception of a nutritionally unbalanced diet), an information barrier (misunderstanding of a plant-based meat diet's benefits), a social barrier

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(social unacceptance), and a financial barrier (expensive plant-based meat products). Many food scientists and engineers have engaged in improving quality and reducing production costs (Boukid, 2021) of plant-based meat; however, most work has focused on motivational factors and barriers while overlooking the marketing techniques to encourage plant-based meat consumption. As one of the most effective persuasive communication strategies (Lee & Oh, 2014), message framing is insightful in addressing the health barrier, the information barrier, and the social barrier by better communicating plant-based meat information in an individual's decision-making (Ye & Mattila, 2021).

The hospitality literature is no stranger to message framing but features three voids that render investigations of plant-based meat consumption necessary. First, most message-framing studies in hospitality have centered on individuals' sustainable behaviour, such as towel or linen reuse (Blose, Mack, & Pitts, 2015) and food waste reduction (Chen & DeSalvo, 2021). Different from these tangible actions, plant-based meat diners do not have direct control over environmental outcomes: the environmental benefits of plant-based meat consumption are largely contingent on the producers who are responsible for assuaging the environmental impacts during production. As today's diners are presented with multiple and sometimes contradictory messages about food choices, Vainio (2019) speculated that a lack of knowledge and embellished promotional strategies may spark diners' scepticism about the consequences of meat consumption and the benefits of consuming plant-based meat.

Second, current investigations on the message framing effect on plant-based meat consumption have principally relied on the gain- versus loss-framing technique to investigate the effectiveness. The interaction effects of a gain- versus loss-framing strategy with other message variables are unknown (Chi, Denton, & Gursoy, 2021; Ye & Mattila, 2021). Specifically, unlike other sustainable behaviours (e.g., towel reuse and water conservation) that imply a trade-off between personal benefits and benefits for others, plant-based meat

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consumption offers diners additional nutritional and health rewards and at the same time benefits the environment in the long run. When considering activities with multiple advantages (e.g., plant-based meat consumption), the effectiveness of gain versus loss framing must be understood in light of its interaction effects with other message variables, such as message information (health vs. environment) and message description (attribute vs. benefit) (Carfora, Morandi, & Catellani, 2022).

Third, most message-framing research has employed cross-sectional designs to collect responses at a specific time, namely by ascertaining respondents' consumption intentions and the amount they would be willing to pay more after reading a framed message (e.g., Ye & Mattila, 2021; Zhang et al., 2020). This approach assumes that the starting point for people's consumption intentions and willingness to pay more is the same before reading the framed message (Chi et al., 2021). However, dining behaviours are driven by many factors in the pre-consumption stage (Seo & Shanklin, 2007). The starting point is thus unlikely to be identical. In the context of plant-based meat consumption, more longitudinal research is needed to better replicate diners' real decision-making process (Carfora et al., 2022).

Given the aforementioned research gaps, this study was guided by three objectives: (1) to investigate how different message designs change restaurant diners' plant-based meat consumption; (2) to examine the interaction effects of message framing, message information, and message description on the changes in restaurant diners' plant-based meat consumption; and (3) to compare messages' effectiveness (about changes in restaurant diners' plant-based meat consumption intention and willingness to pay more) in terms of message framing, message information, and message description. Drawing on regulatory fit theory, construal level theory, and means-end theory, we adopted a mixed between–within group methodology with a 2 (message framing: gain vs. loss) × 2 (message information: health vs. environment) × 2 (message description: attribute vs. benefit) scenario-based

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experimental design to understand changes in restaurant diners' plant-based meat consumption intentions (CI) and the amount they would be willing to pay more ($WTP) for a plant-based meal before and after the intervention using eight different message designs.

The findings from this study fill existing gaps within messaging framing in sustainable development by advancing our understanding of fostering individual's plant-based meat consumption. This study also provides practical contributions to restauranteurs, plant-based meat producers, and governments by comparing the effectiveness of message interventions to promote sustainable dining behaviours.

2. Literature review and hypothesis development

2.1. Plant-based meat consumption

Meat eating is popular in modern societies, with the proportion of meat-eaters ranging from 60% in India to 97% in America (Bastian & Loughnan, 2017). Meat is an excellent source of protein, other nutrients, and calories in the human diet. However, meat-eating is associated with a higher risk of cardiovascular and colon diseases caused by cholesterol in animal-derived foods (Micha, Wallace, & Mozaffarian, 2010). The outbreak of bovine spongiform encephalopathy crisis (mad cow disease), the dioxin crisis, and the outbreaks of avian influenza (bird flu) led to the mass media reporting numerous messages linking meat consumption to health risks (Tziva et al., 2020).

In addition to potential health risks, meat consumption has generated cognitive dissonance due to psychological discomfort from the idea of eating meat while caring for animals (Festinger, 1957). Simoons (1994) proposed the 'meat paradox' that refers to a person's state where one cares for and yet harms other animals while some people enjoy eating meat but are unwilling to kill another sentient creature. In some religions, meat-eating is considered sinful

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(e.g. Jainism), while some stress compassion for animals (e.g. Islam). Hence, many companies have begun to develop meat substitutes, with Statista (2022) reporting a 419.8% increase in the total consumption of these foods between 2013 and 2022.

Compared with other meat substitutes (e.g., culture-and insect-based meats), plant-based meat has the greatest potential to become a mainstream product—not only thanks to its high technical robustness and scalability for production but also because plant-based proteins are not foreign to consumers (He et al., 2020). Along with the recent launch of plant-based meat brands, such as Beyond Meat™ and Impossible™, plant-based meat is promoted as the future of food. Plant-based meat consumption has also been recognized as a form of green dining: abundant scientific evidence shows that plant-based diets promote environmental sustainability and public health (Hartmann & Siegrist, 2017).

Despite the superiority of plant-based meat over traditional meat in terms of environmental and nutritional value, plant-based meat only totalled a mere 0.81% of meat-market sales (Richter, 2022). Vainio (2019) pointed out that many people are unwilling to pursue plant-based diets due to being ill-informed of the benefits of plant-based meat consumption and the risks of conventional meat consumption. Other scholars have echoed this claim upon discovering that advertising and packaging messages which offer consumers necessary information can boost people's intentions to try, and willingness to pay more for, plant-based diets (Carfora et al., 2017). Nonetheless, these studies were mainly conducted in the grocery context, limiting their generalizability to restaurants. The restaurant setting is unique for its nature to allow for permissive dining behaviors (Okumus, 2020) that are associated with less healthy diets. Ye and Mattila (2021) called for specific investigation of plant-based consumption in this context to promote plant-based diets to consumers effectively.

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2.2. Message framing at restaurants

Message framing stems from Kahneman and Tversky's (1979) framing theory, entailing a complex psychological process through which people interpret and react to messages based on how the information is presented. Since Lee and Oh (2014) indicated message framing as a highly persuasive communication strategy in influencing consumer behaviour, it has generated extensive attention in the restaurant literature. Researchers have explored how messages can be drafted to alter consumers' habits, such as those related to food allergies (Wen & Lee, 2020) and unhealthy consumption (Zhang et al., 2020). Plant-based meat consumption has also been trumpeted as a solution to unsustainable food production and distribution systems (de Boer & Aiking, 2017). Hence, it is important to explore how message framing can shape and sustain dietary shifts in different catering venues (Graça et al., 2019), such as restaurants.

2.2.1. Applying regulatory fit theory: Gain versus loss framing

Tversky and Kahneman (1981) introduced message-framing strategies by drawing on the prospect theory to interpret people's behaviour as a trade-off between benefits and risks. One of the most popular framing techniques involves spotlighting either the potential benefits or avoidable negative consequences of a given action (de Boer & Aiking, 2017). A gain-framed message emphasizes the positive outcomes of complying with a recommended behaviour, whereas a loss-framed message stresses the adverse effects of noncompliance (Chang & Wu, 2015). Aligning with prospect theory, early work revealed that loss-framed messaging is more effective than gain-framed messaging, with Meyerowitz and Chaiken (1987) stating that "negative information exerts a greater impact on judgement than does objectively equivalent positive information" (p. 501).

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However, many scholars later challenged that argument by positing that the effectiveness of gain- or loss-framing strategies depends on several factors: the risks of not performing an action (Amatulli et al., 2019) and types of recommended behaviour (Chang & Wu, 2015). For example, O'Keefe and Jensen (2007) conducted a meta-analysis of 93 healthcare studies on gain-/loss-framed messages and identified a significant advantage of gain-framed messages over loss-framed messages. Similar conclusions have emerged in hospitality (Tanford, Kim, & Kim, 2020; Wen & Lee, 2020; Xu & Jeong, 2019). Instead of stemming on the prospect theory, Chi et al. (2021) drew on regulatory fit theory to argue that gain-framed messages should be more suitable in the hospitality industry as the gain-oriented approach aligns with the social norm in hospitality that a sincerely hospitable service provider should make guests feel satisfied (Blose et al., 2015).

Regulatory fit theory posits that individuals are more motivated to engage in tasks when they perceive "fit" between their main objectives and the tasks involved (Higgins, 2000). In contrast to the prospect theory, which advocates that risk aversion is more important in one's decision-making process, regulatory firt theory goes a step further by focusing on the match between a person's regulatory focus–either benefit-seeking or risk-avoiding (i.e., risk aversion)–and their strategy for pursuing goals or the consequences they focus on when making decisions (Motyka et al., 2014). Given the benefit-seeking nature of hospitality activities, many scholars adopted regulatory fit theory to demonstrate the superiority of gain-framed messages in fostering consumers' desired behaviors, such as consumers' willingness to pay a premium for pro-environmental hotels (Su & Li, 2024) and food waste reduction practices in restaurants (Zhang et al., 2020). In this line of thinking, as most individuals dine in restaurants to filulfill their desire for positive experiences, a loss-framing technique contradicts restaurant diners' primary goals of pursuing a satisfactory dining experience. Based on the preceding discussion and existing empirical results in the hospitality industry

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(e.g., Blose et al., 2015; Tanford et al., 2020), we assumed a benefit-seeking focus of restaurant diners and hypothesized that:

H1. A gain-framed message triggers more changes in diners' CI and $WTP for a plant-based diet than a loss-framed message.

2.2.2. Applying construal level theory: Health versus environment information

Liberman and Trope (1998) created construal level theory to suggest that distant future events are interpreted or construed by individuals in more abstract terms. In construal level theory, researchers proposed that an individual's decision-making is influenced by four different dimensions of psychological distances (Liberman, Trope, & Wakslak, 2007): temporal distance (indeterminate future vs. very near term), social distance (many degrees of separation vs. a close contact), spatial distance (very far away vs. near at hand), and hypotheticality distance (unlikely to happen vs. very likely to happen). As a theory that examines how information meaning varies across an individual's perceived psychological distance (Trope & Liberman, 2010), construal level theory has been recognized as a useful lens through which to understand message persuasion (Septianto, Lee, & Putra, 2021).

These four dimensions point to the possibility of construal level theory to promote plant-based meat consumption because plant-based meat consumption is thought to induce benefits or reduce risks in two respects: personal health and the environment (Graça et al., 2019). Personal health was less psychologically distant than the environment based on the four dimensions. Temporally, health diseases related to excessive meat consumption were usually found in people aged between 55 and 89 (Susanna, Jarmo, & Alicja, 2011), which is around 50 years later after their meat consumption. However, despite the extensive discussions on climate change and global warming, the future of the environment caused by excessive meat consumption is largely unforeseen. Socially and spatially, personal health highlights the

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consideration from the perspective of self, while the environment is described from the perspective of others (Kim, 2011). Hypothetically, illness and death are inevitable for every individual, but many individuals still believe climate change is a myth (Pasquini et al., 2023).

Personal health and the environment feature relevant message-framing strategies, with many scholars comparing the effectiveness between health and environment messages in encouraging desired behaviour (Chi et al., 2021; Xu & Jeong, 2019). However, the effectiveness of health and environment messages remains largely inconclusive in the hospitality literature (e.g., Vainio, 2019; Zhang et al., 2020). Hence, investigations on the interaction effect of whether messages are gain- or loss-framed are essential to provide a comprehensive understanding of the comparison between health and environment messages.

Health messages, as a type of less psychologically distant information, emerge from an egoistic view highlighting the possible benefits or risks of performing a certain behaviour; environment messages, as a type of more psychologically distant information, arise from an altruistic perspective, reflecting how an action may benefit or harm the environment and the greater society. For example, Pittman (2020) adopted the egoistic perspective to design a message that presents health benefits of participating in Meatless Monday activity, whereas designed an altruistic message to explain environmental benefits. Taken the egoistic and altruistic perspectives into consideration, egoistic individuals were found to value what can be achieved than what should be avoided (Schwartz, 1992). According to the goal-frame theory (Lindenberg, 2001), goals (i.e., achievements) that are relevant to the individuals and are active in their mind "influence what persons think of at the moment, what information they are sensitive to, what action alternatives they perceive, and how they will act" (Lindenberg & Steg, 2007, p.119). Highly egoistic individuals should then be particularly sensitive to achievement-oriented information (Lagomarsino, Lemarié, & Puntiroli, 2020). Considering health information from an egoistic perspective, we hypothesize that:

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H2a. When communicating health information, a gain-framed message triggers more changes in diners' CI and $WTP for a plant-based diet than a loss-framed message.

In contrast, when individuals hold a more altruistic viewpoint, they focus more on responsibility and ponder how their actions might harm others (Aaker & Lee, 2001). As a technique that aligns with one's avoidance system, a loss-framed message was found more effective in fostering water conservation behaviours for individuals primed with shame (Baek & Yoon, 2017), which has widely recognized as an important emotion fostering altruistic behaviours (Shott, 1979). Considering environment information from an altruistic perspective, we hypothesized that:

H2b. When communicating environment information, a loss-framed message triggers more changes in diners' CI and $WTP for a plant-based diet than a gain-framed message.

2.2.3. Applying means-end theory: Attribute-based versus benefit-based description

Means-end theory frequently appears in the hospitality literature because it aligns well with an industry tenet: the meanings of a product or service are not contained in its absolute characteristics but in its functional and psychosocial benefits based on customers' values (Claeys, Swinnen, & Abeele, 1995). This theory depicts a value hierarchy indicating that a product or service can be judged concretely by its attributes and abstractly by its benefits. Specifically, abstractness is not interchangeable with vagueness; it is a process of reconstructing one message into another that has a higher-level meaning (Trope, Liberman, & Wakslak, 2007), for instance, 'reducing carbon emission' becomes 'supporting sustainable development'.

As a theory that distinct the concepts of attributes and benefits based on their abstractness, means-end theory was linked with construal level theory to encourage its application in message framing (Hernandez, Wright, & Ferminiano Rodrigues, 2015). Trope and Liberman

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(2010) suggested that with more psychologically distant events, individuals tend to use words rather than pictures (which are concrete representations of words), fewer and more board categories, and think about why they should take action rather than how to take it. In brief, a benefit-based message focuses on values and describes consumption outcomes abstractly, whereas an attribute-based message details a product's features using qualitative information.

Whether using an attribute-based or benefit-based appeal is more effective represents a long-standing question in the advertising field. The utility of either type is tied to a person's perceived cognitive effort in processing information (Maheswaran & Sternthal, 1990). The benefit-based message seeks to convey what message recipients will receive from executing a behaviour. Such information, therefore seems more effective for novices who would prefer not to engage in additional interpretation. However, people who are comfortable processing the information independently (e.g., experts) have been shown to favour attribute-based information (Park & Kim, 2008). Xu and Jeong (2019) noticed that excessive and sometimes conflicting information about sustainable practices led diners to value benefit-based information over attribute-based information at green restaurants. Still, the interaction effect with message information (health vs. environment) must be considered to paint a comprehensive picture (Ye & Mattila, 2021).

Different from the green restaurant practices (e.g., using sustainable food ingredients) that Xu and Jeong (2019) investigated, the environmental benefits of plant-based meat consumption are thought to be more easily understood. These benefits revolve around resource reduction (e.g., water/land use and greenhouse gases) (Graça et al., 2019). Diners may value attribute-based information over benefit-based information when contemplating the environmental advantages of plant-based meat consumption because they can more readily process such information. Xu and Jeong (2019) mirrored this line of thought upon uncovering non-significant differences between attribute-based and benefit-based information when

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describing green restaurant practices (e.g., saving water and energy) on diners' attitudes towards restaurants and their visit intentions. Hence, we hypothesized that:

H3a. When communicating environment information, an attribute-based description triggers more changes in diners' CI and $WTP for a plant-based diet than a benefit-based description.

Diners generally encounter more difficulty in interpreting health information because it includes nutritional details regarding a meal's amount of calories, saturated fat, cholesterol, and carbohydrates (Graça et al., 2019). Even diners conversant with these nutrition terms will need to devote additional effort to tie this information to health benefits or risks (Vainio, 2019). Miller and Cassady (2015) believed that one's ability to evaluate the relevance and quality of information guides their understanding of science-based nutrition information. Our final hypothesis is as follows, and our proposed research model appears in Figure 1:

H3b. When communicating health information, a benefit-based description triggers more changes in diners' CI and $WTP for a plant-based diet than an attribute-based description.

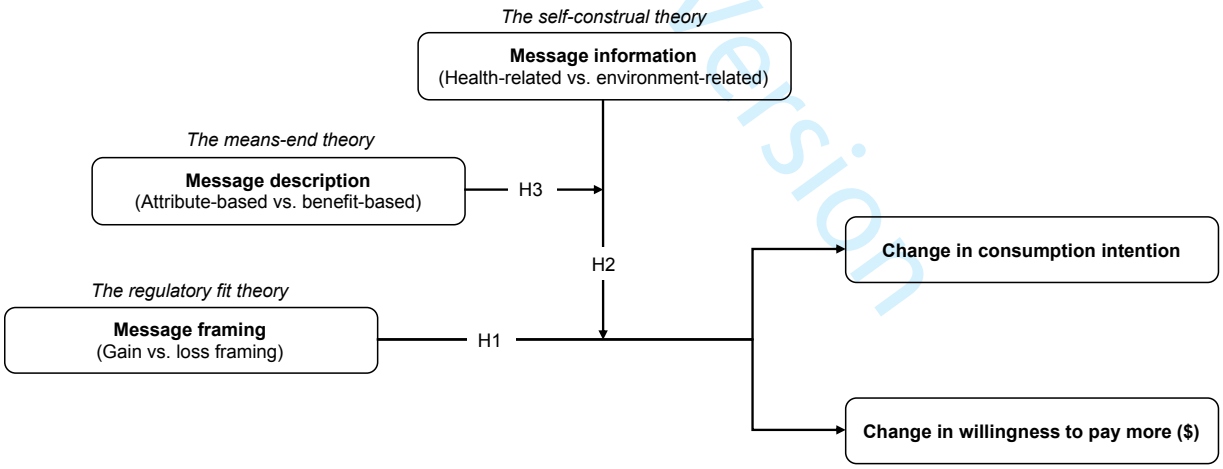

Figure 1. Proposed research model

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3. Method

3.1. Study context

China was selected as the study setting for three main reasons. First, China is one of the largest markets in the global plant-based meat industry, representing 53% of the market share in the industry and contributing around USD$1.44 billion to the industry (Daxue Consulting, 2022). Second, the country is also one of the largest consumers in the global meat industry, consuming 28% of the world's meat (Reid, 2021). Many governmental and media efforts have been made to promote plant-based meats in order to support the sustainable development of the food industry (Chan, 2020). Third, while many plant-based meat developers' operations are based in the Western market, the rising trend of flexitarianism in China have made it a steppingstone into the Asian market. Allen (2019) reported that more than 86.7% of Chinese non-vegetarians consume plant-based meat products despite over 90% of them not identifying themselves as vegan. Hence, investigations on the Chinese context are of great practical implications for plant-based meat promotion.

3.2. Data collection

3.2.1. Persuasive message design

This study adopted a mixed between–within group methodology including a 2 (message framing: gain vs. loss) × 2 (message information: health vs. environment) × 2 (message description: attribute vs. benefit) scenario-based experimental design to address the three research objectives. Based on a real example in Hong Kong (i.e., a five-star hotel offering a set lunch at HKD$248 (approximately USD$32) with an option to upgrade from a traditional beef burger to an Impossible Burger™), eight scenario-based text-only framed messages were developed to examine their effects on diners' CI and $WTP for a plant-based diet

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(Figure 2). An exemplar five-star hotel was adopted to create the scenario; the chosen hotel is one of Hong Kong's most famous offering plant-based meat. The fixed research context also helped to eliminate confounding effects from other external variables (e.g., restaurant type and plant-based meat brand). Each message consisted of three interventions: gain- versus loss-framing, health versus environment information about an Impossible Burger™, and an attribute- versus benefit-based description.

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Message 1: Gain*Health*Attribute

If you choose to upgrade to a plant-based meat burger (Impossible Burger), you can reduce risks of heart disease, stroke, cancers, and all-cause mortality. The following is the nutrition comparison between a Beef Burger and a plant-based meat burger (Impossible Burger):

Nutrition	Beef Burger	Impossible Burger	Difference
Calories	420g	240g	-180g
Total Fat	35g	14g	-21g
Saturation Fat	15g	8g	-7g
Cholesterol	110g	0g	-110g
Carbohydrate	0g	9g	+9g

Message 2: Loss*Health*Attribute

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you will have higher risks of heart disease, stroke, cancers, and all-cause mortality. The following is the nutrition comparison between a Beef Burger and a plant-based meat burger (Impossible Burger):

Nutrition	Impossible Burger	Beef Burger	Difference
Calories	240g	420g	+180g
Total Fat	14g	35g	+21g
Saturation Fat	8g	15g	+7g
Cholesterol	0g	110g	+110g
Carbohydrate	9g	0g	-9g

Message 3: Gain*Health*Benefit

If you choose to upgrade to plant-based meat burger (Impossible Burger), you can reduce risks of heart disease, stroke, cancers, and all-cause mortality. A plant-based meat burger (Impossible Burger) utilizes:

- Soy and potato proteins to deliver essential nutrition
- Coconut and sunflower oils for juicy sizzle
- Yeast extract (a natural flavour) to create a meat flavour

Message 4: Loss*Health*Benefit

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you will have higher risks of heart disease, stroke, cancers, and all-cause mortality. A Beef Burger contains:

- Excessive amounts of cholesterol that increase the chances of heart disorders
- Excessive amounts of saturated fat that damage one's arteries
- Excessive amounts of sodium that result in increased blood pressure

Message 5: Gain*Environment*Attribute

If you choose to upgrade to plant-based meat burger (Impossible Burger), you are protecting our environment. The production of a plant-based meat burger (Impossible Burger) **REDUCES**:

- 87% water usage
- 89% greenhouse gas emissions
- 96% land usage

Message 6: Loss* Environment*Attribute

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you are polluting our environment seriously. The production of a Beef Burger **INCREASES**:

- 87% water usage
- 89% greenhouse gas emissions
- 96% land usage

Message 7: Gain*Environment*Benefit

If you choose to upgrade to plant-based meat burger (Impossible Burger), you are protecting our environment. The production of a plant-based meat burger (Impossible Burger) **REDUCES**:

- water usage to ensure there is enough clean water for all of us
- greenhouse gas emissions to limit global warming
- land usage to protect biodiversity and wildlife

Message 8: Loss* Environment* Benefit

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you are polluting our environment seriously. The production of a Beef Burger **INCREASES**:

- Water usage that results in water shortage
- Greenhouse gas emissions that foster global warming
- Lands usage that harms biodiversity and wildlife

Figure 2. Eight framed messages

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The comparison between a traditional beef and an Impossible Burger™ was adopted from a consulting report (Taylor & Gal, 2019) and the information from the official website of Impossible Foods (https://impossiblefoods.com). Reports from the Hong Kong Trade Development Council (Chan, 2020), from 21st Century News Group (2022), and from China's State Administration of Market Regulation (Koe, 2023) were also consulted to ensure that the eight framed messages complied with the official description of plant-based meats in China. Specifically, in addition to the environmental claims that are commonly listed on plant-based meat products' packages, the health claims in the framed messages also aligns with the regulation for food claims in China. In August 2023 (i.e., one month before the experiment was taken place), to better develop health industries, the Chinese government officically announced that food functionalities "to maintain or improve health conditions of the human body" and "to reduce the risk of incurring diseases" are allowed to be claimed by food producers after conducting scifientic research through local Chinese qualified laboratories (Koe, 2023). It is unsurprising that some China-based plant-based meat producers such as Uni-Win (2021) and Omnifoods (2024) have adopted direct claims as exemplified in the framed messages to emphasize the health functionalities of plant-based meats.

The eight framed messages were initially developed in English and translated into Chinese by the third author to reach a broader population. The first author then performed back-translation to ensure that all Chinese messages accurately captured their English-language meanings. Both the first and third authors are native Chinese speakers with professional proficiency in English. Prior to the main data collection, these messages were piloted with 80 Chinese respondents (10 respondents per message) to evaluate the manipulation. Specifically, pilot respondents were required to indicate on 7-point bipolar scales whether the randomly assigned message was gain- or loss-framed (1=*loss-framed*; 7=*gain-framed*), whether the

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message reported health or environment information (1=*health focus*; 7=*environment focus*), and whether the information was attribute-based (i.e., presenting information in a concrete way) or benefit-based (i.e., presenting information in an abstract way) (1=*attribute-based*; 7=*benefit-based*). At the end of the pilot survey, respondents were asked to rate the perceived credibility and understandability of the message (1=*strongly disagree*; 7=*strongly agree*).

The message manipulation was validated through a series of independent sample *t* tests. Results suggested that the gain-framed messages (M=6.475) were significantly more gain-focused (t=20.942, p<0.001) than the loss-framed messages (M=3.451); the health messages (M=3.579) were perceived to be more healthfocused (t=-13.397, p<0.001) than the environment messages (M=5.590); and the attribute-framed messages (M=3.028) were perceived to be more concrete (t=-12.864, p<0.001) than the benefit-framed messages (M=5.156). In addition to the high mean values on the eight messages' perceived credibility ($_{PC}$) ($\bar{x}$=6.316) and perceived understandability ($_{PU}$) ($\bar{x}$=6.407), non-significant differences applied to these characteristics (F_{PC}=0.735, p>0.05; F_{PU}=0.326, p>0.05).

3.2.2. Survey design

The online self-administered survey was designed on the Qualtrics platform and distributed by a professional survey company (independent from this study) to its panel members who received compensations from the company. Before the start of the survey, two screening questions were asked to ensure that respondents were 18 years or older and were currently living in China. Respondents were next presented with a brief definition of plant-based meat (*"'Plant-based meat' is a food product made from vegetarian or vegan ingredients, eaten as a replacement for meat. It is frequently made with soy [e.g., tofu, tempeh, and textured vegetable protein]"*.) and Impossible Burger™ (*"'Impossible Burger' is a signature product of Impossible Foods Inc. It is made with plant-based meat by selecting proteins and nutrients from plants."*). They were then told to imagine that they were ordering a HKD$248

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(approximately USD$32) set lunch with a beef burger at a five-star hotel in Hong Kong before rating their intention to upgrade to an Impossible Burger™ (CI) using a 7-point bipolar scale anchored by "strongly disagree" and "strongly agree." Based on the common pricing strategy to round up an item to the nearest $5 or $10 (Kohli & Suri, 2011), the respondents were required to indicate the amount (in increments of HKD$5 between HKD$0 and HKD$100) they would be willing to spend on an upgrade ($WTP). This direct approach prevented hypothetical bias and provided standardized values to calculate the change in diners' anticipated behaviour (Chi et al., 2021).

After that, respondents were randomly shown one of the eight framed messages (Figure 2) and were required to rate the three manipulation statements again. Unlike other longitudinal studies that usually record individual's attitudinal change after weeks (e.g., Chi et al., 2021), this study adopted a micro-longitudinal approach to record respondents' answer over a small period of time. By definition, a micro-longitudinal study is a "study's methodological concern for detailed attention to changes in formulations across similar episodes of the same speech event, although not across long periods of time" (Greer, 2016, p. 81).

There are two main reasons that make a micro-longitudinal approach suitable for this study. First, as a dynamic approach that captures variations on respondents' immediate reactions (Beghetto & Karwowski, 2019), this micro-longitudinal approach has widely been adopted in the education literature to understand how information is dismissed, accepted, and returned (e.g., Li, Mayer, & Malmberg, 2022). Message framing is an information process in which message receivers obtain and process information from message senders (Nelson, Oxley, & Clawson, 1997). Second, it helps replicate an actual dining situation in which service providers upsell food items when taking diners' orders in a high-ended hotel setting (i.e., a five-star hotel). Compared to other decision-making processes in tourism (e.g., buying a flight ticket and booking a hotel), the decision-making processes at restaurants are shorter.

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Restaurant diners are usually required to make a decision (i.e., placing an order) within around 10 minutes. Hyun et al. (2016) argued that impulsive ordering behaviours are popular in luxury restaurants, because the aroma of food in the restaurant and being delivered to other tables focus diners to make decisions urgent. Hence, to reflect the impulsive consumption environment in restaurants, respondents were asked to indicate their CI and $WTP once after they read the randomly-assigned framed message. The degree of change following the framed message was calculated with the following formulas:

$$\Delta BI = BI_{after} - BI_{before}$$

$$\Delta \$WTP = \$WTP_{after} - \$WTP_{before}$$

The last section consisted of open- and closed-ended questions to collect respondents' demographics (gender, age, place of residence, educational level, and monthly income level) and behavioural characteristics (number of vegetarian meals eaten per week). The research design is illustrated in Supplementary Figure 1.

Actual data collection took place over two weeks and resulted in 377 complete surveys. In line with Lin et al.'s (2020) suggestions, two criteria were adopted to eliminate invalid responses: surveys completed within less than 30 seconds (n=11) and surveys with an incorrect response to an attention-check question (n=5). In all, 361 valid surveys were retained for further analyses. Our group sample sizes ranged from 42 to 48, meeting the central limit theorem of 30 valid responses for each message to support the implementation of subsequent parametric test in an experimental research setting.

3.3. Data analysis

Data analysis consisted of five stages to analyse valid responses in IBM SPSS 27.0. First, a series of independent sample t-test was conducted to validiate the message manipulation again. Second, chi-square analyses and one-way analyses of variance (ANOVAs) were

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conducted to discern demographic and behavioural differences between the eight respondent groups, affirming groups' similarity to prevent confounding effects during group comparison. Third, adopting the within-subjects design approach, several paired sample *t* tests were performed to ascertain whether respondents' initial CI and $WTP differed significantly from their responses after reading the message. This step addressed the first research objective. Fourth, adopting the between-subjects design approach, a three-way ANOVA was run to examine the interaction effects of message framing, message information, and message description, thereby addressing the second objective. Lastly, a multivariate analysis of variance (MANOVA) with Turkey post-hoc tests was used to compare the effectiveness of the eight framed messages on fostering changes in respondents' CI and $WTP, which covered the third objective.

4. Results

4.1. Sample profile

Most respondents were women (66.2%) and held a bachelor's degree or above (83.6%), with an average age of 30.1 years. While most respondents (56.2%) earned less than USD$1,913 monthly, their relatively low-income level led to valuable insight on promoting plant-based diets as mainstream food products: the sample mainly consisted of inexperienced vegetarians who ate only 3.3 vegetarian meals per week. The results of chi-square analyses and one-way ANOVAs suggested that the message groups are not different with each in terms of all demographic and behavioural attributes (Supplementary Table 1), thus minimizing confounding effects of factors other than the framed message on respondents' changes in CIs and $WTP.

4.2. Effectiveness of the eight framed messages

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Several paired-sample *t* tests were carried out to compare respondents' CI and $WTP for a plant-based diet before and after reading one of the eight framed messages (Supplementary Table 2). Findings substantiated the effectiveness of message interventions, as respondents' CI (t=4.346, p<0.001) and $WTP ($t$=8.516, p<0.001) were significantly higher after reading the framed messages. Specifically, gain-framed messages (ΔBI=0.745; $\Delta\$WTP$=8.519) were significantly more effective in fostering changes in respondents' CI and $WTP than loss-framed messages (ΔBI=-0.150; $\Delta\$WTP$=3.544), lending support to H1.

Table 1. Interaction effects of three message characteristics

Variables	ΔCI			$\Delta\$WTP$		
	df	*MSE*	*F*	*df*	*MSE*	*F*
Main effects						
Gain vs. loss (GL)	1	61.184	69.698***	1	1843.820	11.945***
Health vs. environment (HE)	1	0.001	0.001^{ns}	1	1041.197	6.745***
Attribute vs. benefit (AB)	1	8.736	9.952**	1	9.266	0.060^{ns}
Interaction effects						
GL*HE	1	91.415	104.135***	1	2481.490	16.076***
GL*AB	1	11.562	13.171***	1	115.212	0.746^{ns}
HE*AB	1	91.415	101.178***	1	3747.849	24.280***
GL*HE*AB	1	5.907	6.729**	1	671.430	4.350*
Error		309.882			54488.893	
Total		624.444			77800.000	

Notes. ***p<0.001; ** p<0.005; * p<0.05; ^{ns} p>0.05.

The three-way ANOVA suggested a significant interaction effect between message framing and message information on changes in respondents' CI (F=104.135, p<0.001) and $WTP ($F$=16.076, p<0.001) (Table 2). When communicating health information, gain-framed messages produced significantly more positive impacts (Message 1: ΔBI=0.884; $\Delta\$WTP$ =10.465; Message 3: ΔBI=1.574; $\Delta\$WTP$=15.000) than loss-framed messages (Message 2: ΔBI = -1.597; $\Delta\$WTP$ = -1.458; Message 4: ΔBI=0.348; $\Delta\$WTP$=7.222), supporting H2a. Conversely, despite the non-significant differences between the gain- (Message 5: $\Delta\$WTP$

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=7.391; Message 7: Δ$*WTP*=2.262) and loss-framed messages (Message 6: Δ$*WTP*=8.690; Message 8: Δ$*WTP*=-0.833) on changes in respondents' $WTP, loss-framed messages generated more changes in CI (Message 6: Δ*BI*=0.675; Message 8: Δ*BI*=0.097) than gain-framed messages (Message 5: Δ*BI*=0.652; Message 7: Δ*BI*=-0.190) when communicating environment information, partially supporting H2b (Figure 3a).

The three-way ANOVA indicated that the effectiveness of communicating health and environment information on changes in respondents' CI (F=101.178, p<0.001) and $WTP ($F$=24.280, p<0.001) depended on how the information was described (Table 2). When conveying environment information, attribute-based messages produced significantly more positive impacts (Message 5: Δ*BI*=.652; Δ$*WTP*=7.391; Message 6: Δ*BI*=0.675; Δ$*WTP* =8.690) than benefit-based messages (Message 7: Δ*BI*=-0.190; Δ$*WTP*=2.262; Message 8: Δ*BI*=0.097; Δ$*WTP*=-0.833). H3a was supported as a result (Figure 3b). By contrast, the superiority of attribute-based messages (Message 1: Δ*BI*=0.884; Δ$*WTP*=10.465; Message 2: Δ*BI*=-1.597; Δ$*WTP*=-1.458) over benefit-based messages (Message 3: Δ*BI*=1.574; Δ$*WTP*=15.000; Message 4: Δ*BI*=0.348; Δ$*WTP*=7.222) was significantly lower when communicating health information, supporting H3b.

Along with the significant three-way interaction effects for changes in respondents' CI (F=6.729, p<0.01) and $WTP ($F$=4.350, p<0.05) (Figure 3c), a multivariate analysis of variance (MANOVA) was carried out to compare the framed messages' effectiveness (Table 2). Mirroring the three-way ANOVA, findings demonstrated that distinct messages led to significantly different changes in CI (F=47.418, p<0.001) and $WTP ($F$=9.896, p<0.001). In particular, a gain-framed message with a benefit-based description of health information (i.e., Message 3) appeared most effective in fostering changes in respondents' CI and $WTP, whereas a loss-framed message with attribute-based health information (i.e., Message 2) was least effective.

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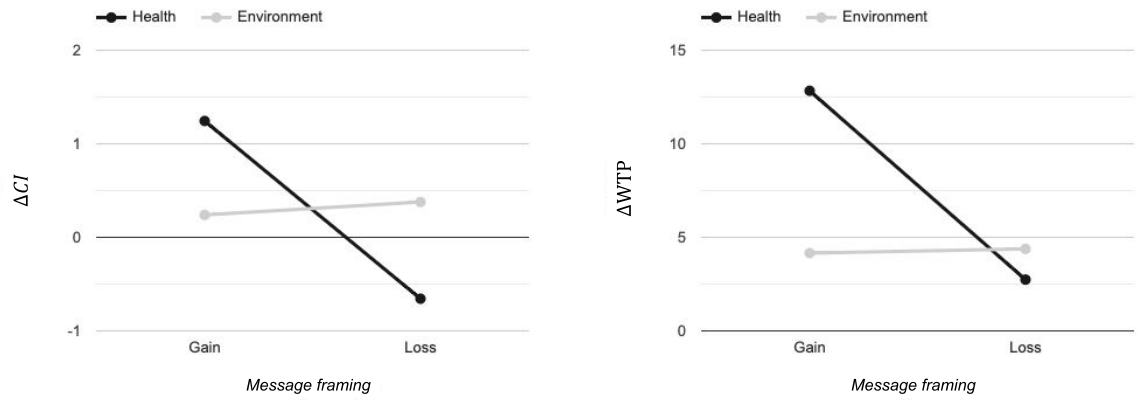
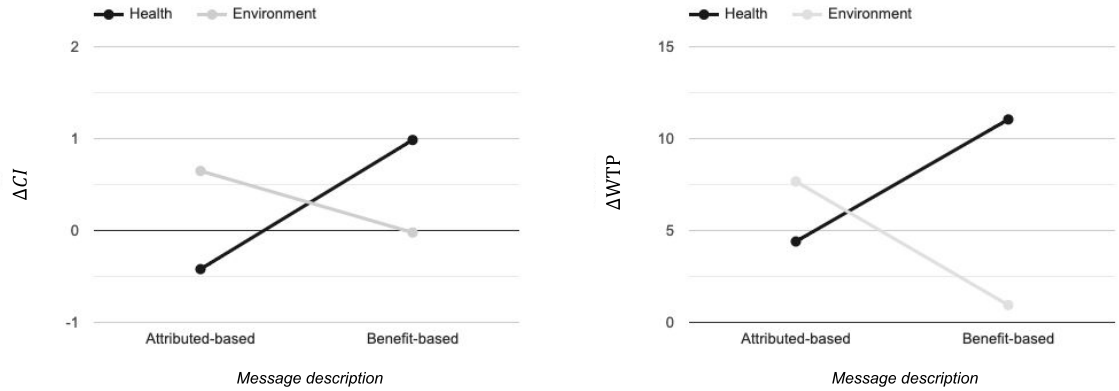
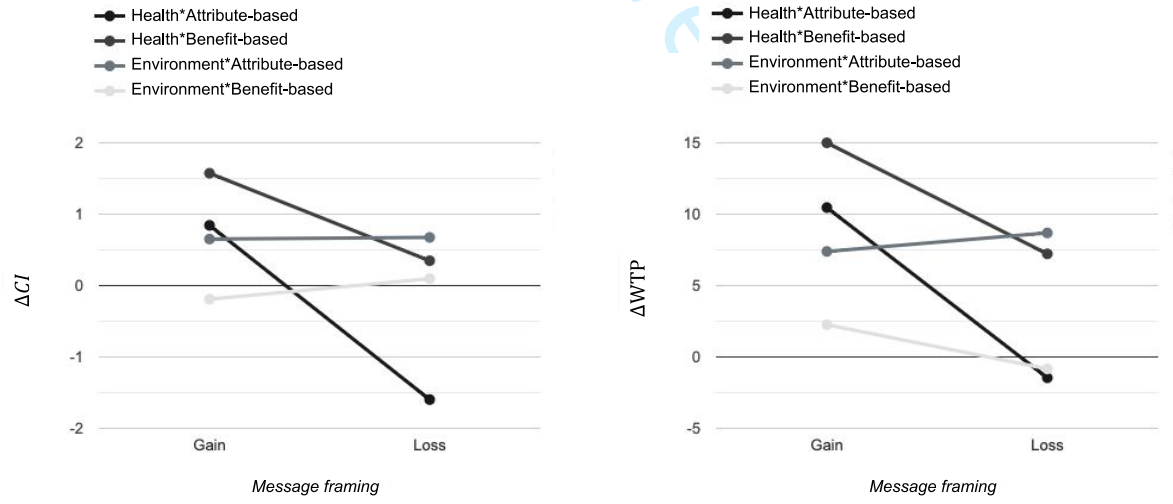


a) Effects of message framing and message information



b) Effects of message information and message description



c) Effects of message framing, message information, and message description

Figure 3. Interaction effects between message framing, message information, and message description

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Table 2. Mean comparison of eight framed messages

ΔCI	Mean	M1	M2	M3	M4	M5	M6	M7	M8
Message 1 (G*H*A)	0.884	-	-2.481***	0.691*	-0.536^{ns}	-0.232^{ns}	-0.209^{ns}	-1.074***	-0.786**
Message 2 (L*H*A)	-1.597		-	3.172***	1.945***	2.249***	2.272***	1.407***	1.694***
Message 3 (G*H*B)	1.574			-	-1.226***	-0.922***	-0.900***	-1.765***	-1.477***
Message 4 (L*H*B)	0.348				-	0.304^{ns}	0.326^{ns}	-0.539^{ns}	-0.251^{ns}
Message 5 (G*E*A)	0.652					-	0.022^{ns}	-0.843**	-0.555^{ns}
Message 6 (L*E*A)	0.675						-	-0.865**	-0.577^{ns}
Message 7 (G*E*B)	-0.190							-	0.288^{ns}
Message 8 (L*E*B)	0.097								-
$\Delta\$WTP$	Mean	M1	M2	M3	M4	M5	M6	M7	M8
Message 1 (G*H*A)	10.465	-	-11.923***	4.535^{ns}	-3.243^{ns}	-3.074^{ns}	-1.775^{ns}	-8.203*	-11.298***
Message 2 (L*H*A)	-1.458		-	16.458***	8.681*	8.850*	10.149**	3.720^{ns}	0.625^{ns}
Message 3 (G*H*B)	15.000			-	-7.778^{ns}	-7.609^{ns}	-6.310^{ns}	-12.738***	-15.833***
Message 4 (L*H*B)	7.222				-	0.169^{ns}	1.468^{ns}	-4.960^{ns}	-8.056*
Message 5 (G*E*A)	7.391					-	1.299^{ns}	-5.129^{ns}	-8.225*
Message 6 (L*E*A)	8.690						-	-6.429^{ns}	-9.524**
Message 7 (G*E*B)	2.262							-	-3.095^{ns}
Message 8 (L*E*B)	-0.833								-

Notes. ΔBI: F=47.418***; $\Delta\$WTP$: F=9.896***; ***p<0.001; **p<0.005; *p<0.05; ^{ns}p>0.05.

5. Discussion and implications

5.1. Discussion

The study findings offer a number of intriguing insights into individuals' plant-based meat consumption. First, H1 was supported to suggest that gain-framed messages were more effective in promoting restaurant diners' plant-based meat consumption than loss-framed messages. Contrary to the premise of loss aversion suggested by prospect theory, the superiority of gain-framed messages was consistent with many message-framing studies in hospitality contexts (e.g., Tanford et al., 2020; Wen & Lee, 2020; Xu & Jeong, 2019). Hospitality activities, including restaurant dining, generally emphasize positive and hedonic experiences that align with the nature of gain-framed messages (Chi et al., 2021), reaffirming regulatory fit theory (Higgins, 2000).

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Second, by examining H2, this study verified two-way interaction effects between message framing (gain vs. loss) and message information (health vs. environment) on changes in individuals' CI and $WTP for a plant-based diet. Gain-framed messages seemed more effective when sharing health information, whereas loss-framed messages were more useful when sharing environment information. These results coincide with construal level theory. The theory posits that an egoistic perspective (e.g., health information) dovetails with what is gained, whereas an altruistic perspective (e.g., environment information) dovetails with what is lost (Lin et al., 2012). The partial insignificant result of H2b reflected a willingness-behaviour inconsistency in the context of plant-based meat consumption (Stack & Michaelson, 2010), because a loss-framed message was only effective to trigger respondents' CI but not their $WTP when communicating environment information. Unlike consumption intention, $WTP required individual's additional considerations. Specifically, the environmental benefits of plant-based meat consumption are largely contingent on the producers who are responsible for assuaging the environmental impacts during production. Given the possible low level of trust for industrial-scale plant-based meat producers (Begho, Odeniyi, & Fadare, 2023), individuals may be skeptical about the environmental outcomes of plant-based meats and thus unwilling to pay them for a premium price.

Third, by examining H3, this study verified another two-way interaction effects between message information (health vs. environment) and message description (attribute vs. benefit) on changes in individuals' CI and $WTP for a plant-based diet. Unlike Xu and Jeong (2019) who demonstrated the superiority of benefit-based messages over attribute-based messages at restaurants to promote green practices, our study suggests that attribute-based messages were more effective in altering respondents' CI and $WTP when sharing environment information. This finding echoes Hernandez et al.'s (2015) assertion that the effectiveness of benefit- and attribute-based messages depends on the extent to which one's thoughts about the outcomes

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are abstract or concrete. Amid growing societal attention to global warming, many people are expected to view environmental protection more concretely (Xu & Jeong, 2019). They may thus expend less cognitive effort when processing attribute-based environment information about plant-based meat. However, individuals could value benefit-based health messages over attribute-based health messages if they perceive nutrition terms as abstract information. In such cases, people must allocate additional cognitive effort to understanding these details (Vainio, 2019).

Lastly, consistent with many studies on vegetarian menu design (e.g., Krpan & Houtsma, 2020), this study verified three-way interaction effects among message framing, message information, and message description. One's dining choices are also driven by a constellation of informational aspects (Ngan et al., 2022). Verain et al. (2017) noted that a combination of factors was more effective than single-framed messages in elevating one's intentions to reduce meat consumption. Depending on different combinations of different message factors, health messages were simultaneously most and least effective in fostering changes in diners' CI and $WTP. Specifically, health messages fostered individual's changes the most when the information is gain-framed in an abstract way (Message 3) but were ineffective when it is loss-framed in a concrete way (Message 2).

5.2. Theoretical implications

This study contributes to the literature by furthering the academic understanding of plant-based meat, message framing, and dining decisions in four ways. First, alongside recent trends related to plant-based meat, this study is one of the few attempts to investigate how to encourage restaurant diners' plant-based meat consumption through message interventions. Since restaurants, as venues known for altering one's dining habits (Roberts & Shea, 2017), have widely been recognized as key stakeholders in promoting sustainable dining, this study enriches our understanding of encouraging plant-based meat consumption, complementing

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the one-sided discussion in the grocery contexts (Ye & Mattila, 2021). This perspective is important not only because the hospitality industry naturally enables consumers to pursue their self-interests (e.g., meat enjoyment) in a permissive and unsustainable fashion (Okumus, 2020), but also because restaurants provide cooked plant-based meats that are expected to be more attractive to mass consumers than those raw products.

Second, despite message framing having graced the hospitality and tourism literature, many investigations have been limited to sustainable activities such as towel reuse at hotels (Blose et al., 2015) and food waste reduction at restaurants (Chen & DeSalvo, 2021). Much less is known about how message-framing techniques can be wielded to promote egoistic behaviour like plant-based meat consumption. Different from other environmentally sustainable actions, plant-based meat consumption appears to reduce risk more for individuals than for society and the environment (Hu, Otis, & McCarthy, 2019). Specifically, compared to environmental information, health information was more effective in altering respondents' CI and $WTP towards plant-based meat consumption, expanding the literature on health behaviour and communication to understand message framing from an egoistic perspective (Wen & Lee, 2020).

Third, in addition to message-framing theory, we turned to regulatory fit theory, construal level theory, and means-end theory to clarify three-way interaction effects among message framing (i.e., gain vs. loss), message information (i.e., health vs. environment), and message description (i.e., attribute vs. benefit). Given considerable inconsistencies in the effectiveness of gain- and loss-framed messages (O'Keefe & Jensen, 2007), many scholars have evaluated how information factors interconnect to influence one's attitudes and behaviour (e.g., Tanford et al., 2020; Wen & Lee, 2020; Xu & Jeong, 2019). Specifically, this study theoretically linked message framing techniques (i.e., gain vs. loss) with construal level

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theory through the lens of egoistm and altruism in message framing. Egoistic information was more effectively gain-framed, whereas altruistic information was better loss-framed.

Lastly, on top of the third theoretical implication, this study theoretically linked construal level theory with means-end theory through the lens of abstractness. Despite the extensive application of construal level theory in message framing literature (Cai & Leung, 2020; Zhang et al., 2020), means-end theory has scarcely been applied in message framing studies. As a popular theory to describe individual's needs in hospitality (Ho, Lin, & Huang, 2014), means-end theory presents the hierarchical nature of consumer value. This hierarchical structure is insightful to message framing, because it offers a firm theoretical background to explain how perceived psychological distance (i.e., a concept emerged from construal level theory) could be applied in message description to foster changes on one's attitudes and behaviours (Hernandez et al., 2015).

5.3. Methodological implications

This study leveraged a micro-longitudinal approach to track changes in respondents' CI and $WTP before and after reading a framed message. This approach does not only rectify methodological deficiencies that rely on cross-sectional designs to assume the same starting point for all respondents in message-framing studies as outlined by Chi et al. (2021), but also parallels an actual dining situation in restaurants when diners are usually given a short-time period to consider upselling options (Hyun et al., 2016). This study design encourages scholars to consider diners' possible impulsive consumption behaviours (Hyun et al., 2016) when designing experimental studies, because individual's decision-making processes in restaurants are shorter than in other contexts.

5.4. Practical implications

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This study also bears practical value for a trio of key hospitality industry stakeholders: restauranteurs, plant-based meat producers, and governments. First, many restaurants view plant-based diets as an opportunity to upsell. Yet restauranteurs should not be overly aggressive in their pricing strategies. Respondents were willing to pay 10% more (i.e., HKD$24.848/HKD$248=10.0%) for a plant-based diet. After the message interventions, their $WTP increased by 2.4% to 12.4% (i.e., HKD$30.859/HKD$248=12.4%). Subject to real market situations in the plant-based meat industry, restaurants could thus consider setting the upsell rate at about 10% -15 % for plant-based diets, maintaining a balance between product appeal and profitability. While the cost of plant-based meats was around 30% above animal meats' (Axworthy, 2023), many scientists have predicted that their cost difference will narrow soon to result in cost advantages of plant-based meats. For example, in the Netherlands, plant-based meats have already been on average €1.36 per kilo cheaper than animal meats (Moleman, 2022). Restauranteurs pioneering or promoting plant-based meat consumption may consider encouraging it via a gain-framed message containing benefit-based health information; this approach appeared most effective among our sample.

Second, plant-based meat producers can refer to these findings to revamp their product packaging and marketing strategies. The package designs of Impossible™ and Beyond Meat™ suggest that plant-based meat producers rely heavily on attribute-based health information, such as "20g of plant protein per serving" and "0mg cholesterol," to promote plant-based meat consumption. However, the effectiveness of such information remains doubtful: this study revealed a benefit-based description to be more appropriate for communicating health information. Environment information requires less cognitive effort for interpretation. Coupled with heightening societal concerns over global warming, mass consumers may not be well acquainted with certain nutrition terms. This unfamiliarity diminishes their purchase intentions.

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Lastly, health authorities or government-based environmental protection departments can also pull guidance from our results. Many governments, such as in Australia where meat consumption is high, have started to promote plant-based meat consumption as a sustainable development strategy (Australian Government, 2022). Despite the cost barrier of plant-based meat, our work offers useful insight to portray plant-based meat as a meat product substitute. Specifically, results suggest that health authorities can craft gain-framed messages with benefit-based descriptions to accentuate the health benefits of plant-based meat. Environmental protection departments may rely on loss-framed messages with attribute-based descriptions to underscore the environmental drawbacks of meat consumption.

5.5. Limitations and future research directions

Although this study was conducted with care, several limitations call for future research. First, we collected responses based on a specific scenario related to a five-star hotel restaurant in Hong Kong. This research design eliminated confounding effects from other variables (e.g., cuisine, restaurant, and cultural background). Second, despite aligning with the recent regulation on food claims in China, the health outcomes of plant-based meats on the framing messages may not be applicable in some countries that prohibit the use of direct claims. Future scholars should continuously explore ways of communicating relevant health benefits to promote plant-based meats. Third, this study designed the framed message using the health and environmental information from an Impossible Burger™ to standardize the experimental design. However, finding generalization to the plant-based meat context should be conducted with caution, as diners' CI and $WTP may vary across different plant-based meat companies (e.g., Beyond Meat™). Fourth, based on the real market situation in the Chinese context, we assumed that plant-based meat is more expensive than other regular meat options, but it may not reflect the real situation in some contexts (e.g., The Netherlands). Hence, the assumption of WTP in the context of plant-based meat consumption

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should be carefully considered and tailored to the nuances of a given context. Lastly, this study forced exclusively on the effectiveness of message characteristics and adopted a micro-longitudinal methodology to migrate potential confounding effects of personal factors (e.g., dining preference and novelty). However, such message-person interacting effects deserves systematic exploration. For example, scholars have suggested that overseas diners' behaviour is predominantly driven by novelty needs (Lin et al., 2021a; 2021b); these customers may be less price-sensitive when trying plant-based meat overseas.

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Table 1. Interaction effects of three message characteristics

Variables	ΔCI			$\Delta \$WTP$		
	df	*MSE*	*F*	*df*	*MSE*	*F*
Main effects						
Gain vs. loss (GL)	1	61.184	69.698***	1	1843.820	11.945***
Health vs. environment (HE)	1	0.001	0.001^{ns}	1	1041.197	6.745***
Attribute vs. benefit (AB)	1	8.736	9.952**	1	9.266	0.060^{ns}
Interaction effects						
GL*HE	1	91.415	104.135***	1	2481.490	16.076***
GL*AB	1	11.562	13.171***	1	115.212	0.746^{ns}
HE*AB	1	91.415	101.178***	1	3747.849	24.280***
GL*HE*AB	1	5.907	6.729**	1	671.430	4.350*
Error		309.882			54488.893	
Total		624.444			77800.000	

Notes. ***$p < 0.001$; ** $p < 0.005$; * $p < 0.05$; ^{ns} $p > 0.05$.

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Table 2. Mean comparison of eight framed messages

ΔCI	Mean	M1	M2	M3	M4	M5	M6	M7	M8
Message 1 (G*H*A)	0.884	-	-2.481***	0.691*	-0.536^{ns}	-0.232^{ns}	-0.209^{ns}	-1.074***	-0.786**
Message 2 (L*H*A)	-1.597	2.481***	-	3.172***	1.945***	2.249***	2.272***	1.407***	1.694***
Message 3 (G*H*B)	1.574	-0.691*	-3.172***	-	-1.226***	-0.922***	-0.900***	-1.765***	-1.477***
Message 4 (L*H*B)	0.348	0.536^{ns}	-1.945***	1.226***	-	0.304^{ns}	0.326^{ns}	-0.539^{ns}	-0.251^{ns}
Message 5 (G*E*A)	0.652	0.232^{ns}	-2.249***	0.922***	-0.304^{ns}	-	0.022^{ns}	-0.843**	-0.555^{ns}
Message 6 (L*E*A)	0.675	0.209^{ns}	-2.272***	0.900***	-0.326^{ns}	-0.022^{ns}	-	-0.865**	-0.577^{ns}
Message 7 (G*E*B)	-0.190	1.074***	-1.407***	1.765***	0.539^{ns}	0.843**	0.865**	-	0.288^{ns}
Message 8 (L*E*B)	0.097	0.786**	-1.694***	1.477***	0.251^{ns}	0.555^{ns}	0.577^{ns}	-0.288^{ns}	-
$\Delta\$WTP$	Mean	M1	M2	M3	M4	M5	M6	M7	M8
Message 1 (G*H*A)	10.465	-	-11.923***	4.535^{ns}	-3.243^{ns}	-3.074^{ns}	-1.775^{ns}	-8.203*	-11.298***
Message 2 (L*H*A)	-1.458	11.923***	-	16.458***	8.681*	8.850*	10.149**	3.720^{ns}	0.625^{ns}
Message 3 (G*H*B)	15.000	-4.535^{ns}	-16.458***	-	-7.778^{ns}	-7.609^{ns}	-6.310^{ns}	-12.738***	-15.833***
Message 4 (L*H*B)	7.222	3.243^{ns}	-8.681*	7.778^{ns}	-	0.169^{ns}	1.468^{ns}	-4.960^{ns}	-8.056*
Message 5 (G*E*A)	7.391	3.074^{ns}	-8.850*	7.609^{ns}	-0.169^{ns}	-	1.299^{ns}	-5.129^{ns}	-8.225*
Message 6 (L*E*A)	8.690	1.775^{ns}	-10.149**	6.310^{ns}	-1.468^{ns}	-1.299^{ns}	-	-6.429^{ns}	-9.524**
Message 7 (G*E*B)	2.262	8.203*	-3.720^{ns}	12.738***	4.960^{ns}	5.129^{ns}	6.429^{ns}	-	-3.095^{ns}
Message 8 (L*E*B)	-0.833	11.298***	-0.625^{ns}	15.833***	8.056*	8.225**	9.524**	3.095^{ns}	-

Notes. ΔBI: $F = 47.418$***; $\Delta\$WTP$: $F = 9.896$***; ***$p < 0.001$; **$p < 0.005$; *$p < 0.05$; $^{ns}p > 0.05$.

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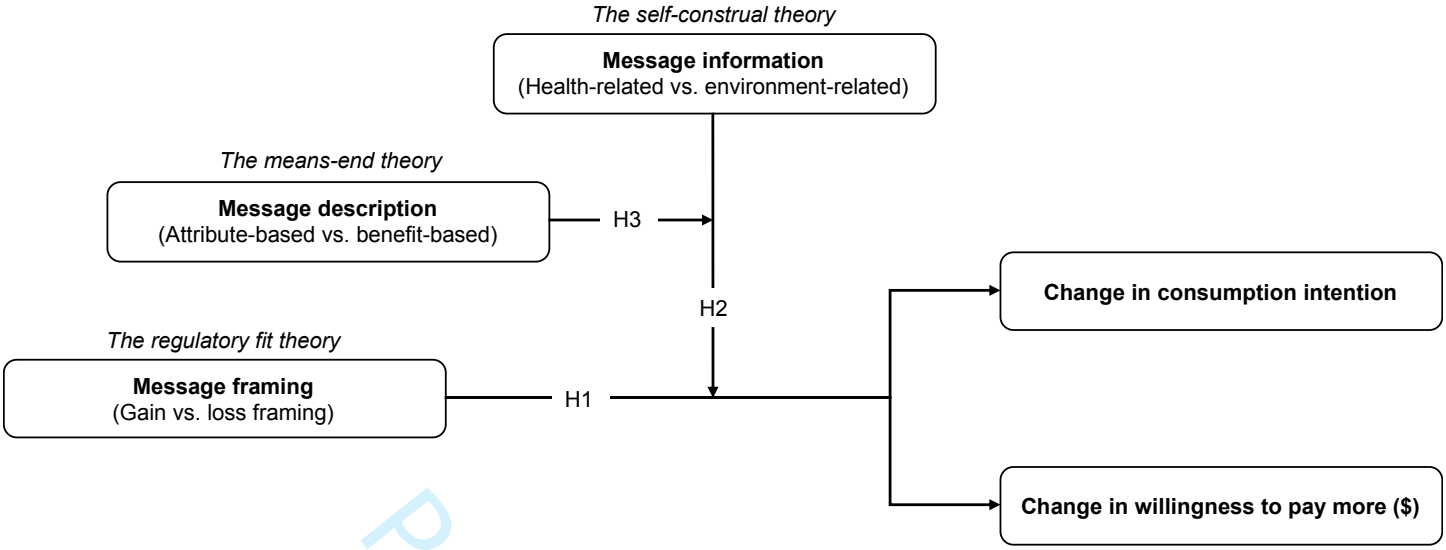

Figure 1. Proposed research model

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Message 1: Gain*Health*Attribute

If you choose to upgrade to a plant-based meat burger (Impossible Burger), you can reduce risks of heart disease, stroke, cancers, and all-cause mortality. The following is the nutrition comparison between a Beef Burger and a plant-based meat burger (Impossible Burger):

Nutrition	Beef Burger	Impossible Burger	Difference
Calories	420g	240g	-180g
Total Fat	35g	14g	-21g
Saturation Fat	15g	8g	-7g
Cholesterol	110g	0g	-110g
Carbohydrate	0g	9g	+9g

Message 2: Loss*Health*Attribute

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you will have higher risks of heart disease, stroke, cancers, and all-cause mortality. The following is the nutrition comparison between a Beef Burger and a plant-based meat burger (Impossible Burger):

Nutrition	Impossible Burger	Beef Burger	Difference
Calories	240g	420g	+180g
Total Fat	14g	35g	+21g
Saturation Fat	8g	15g	+7g
Cholesterol	0g	110g	+110g
Carbohydrate	9g	0g	-9g

Message 3: Gain*Health*Benefit

If you choose to upgrade to plant-based meat burger (Impossible Burger), you can reduce risks of heart disease, stroke, cancers, and all-cause mortality. A plant-based meat burger (Impossible Burger) utilizes:

- Soy and potato proteins to deliver essential nutrition
- Coconut and sunflower oils for juicy sizzle
- Yeast extract (a natural flavour) to create a meat flavour

Message 4: Loss*Health*Benefit

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you will have higher risks of heart disease, stroke, cancers, and all-cause mortality. A Beef Burger contains:

- Excessive amounts of cholesterol that increase the chances of heart disorders
- Excessive amounts of saturated fat that damage one's arteries
- Excessive amounts of sodium that result in increased blood pressure

Message 5: Gain*Environment*Attribute

If you choose to upgrade to plant-based meat burger (Impossible Burger), you are protecting our environment. The production of a plant-based meat burger (Impossible Burger) **REDUCES**:

- 87% water usage
- 89% greenhouse gas emissions
- 96% land usage

Message 6: Loss* Environment*Attribute

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you are polluting our environment seriously. The production of a Beef Burger **INCREASES**:

- 87% water usage
- 89% greenhouse gas emissions
- 96% land usage

Message 7: Gain*Environment*Benefit

If you choose to upgrade to plant-based meat burger (Impossible Burger), you are protecting our environment. The production of a plant-based meat burger (Impossible Burger) **REDUCES**:

- water usage to ensure there is enough clean water for all of us
- greenhouse gas emissions to limit global warming
- land usage to protect biodiversity and wildlife

Message 8: Loss* Environment* Benefit

If you choose **NOT** to upgrade to plant-based meat burger (Impossible Burger), you are polluting our environment seriously. The production of a Beef Burger **INCREASES**:

- Water usage that results in water shortage
- Greenhouse gas emissions that foster global warming
- Lands usage that harms biodiversity and wildlife

Figure 2. Eight framed messages

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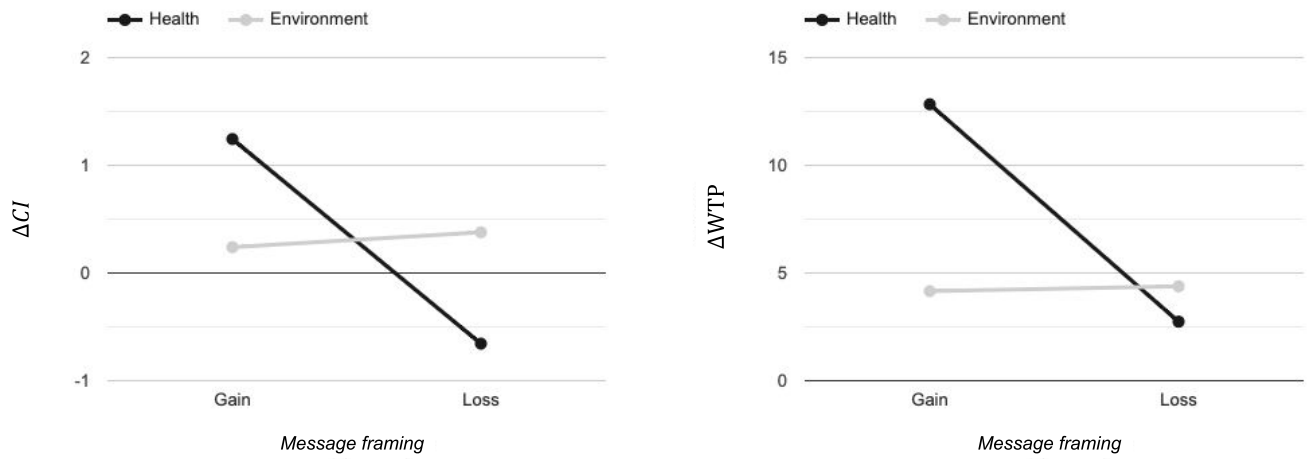
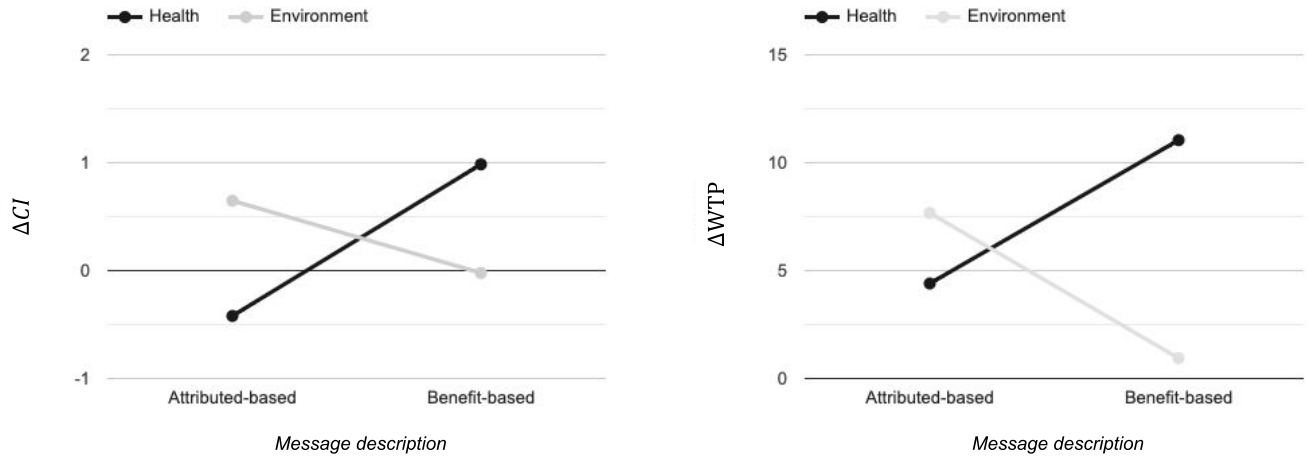
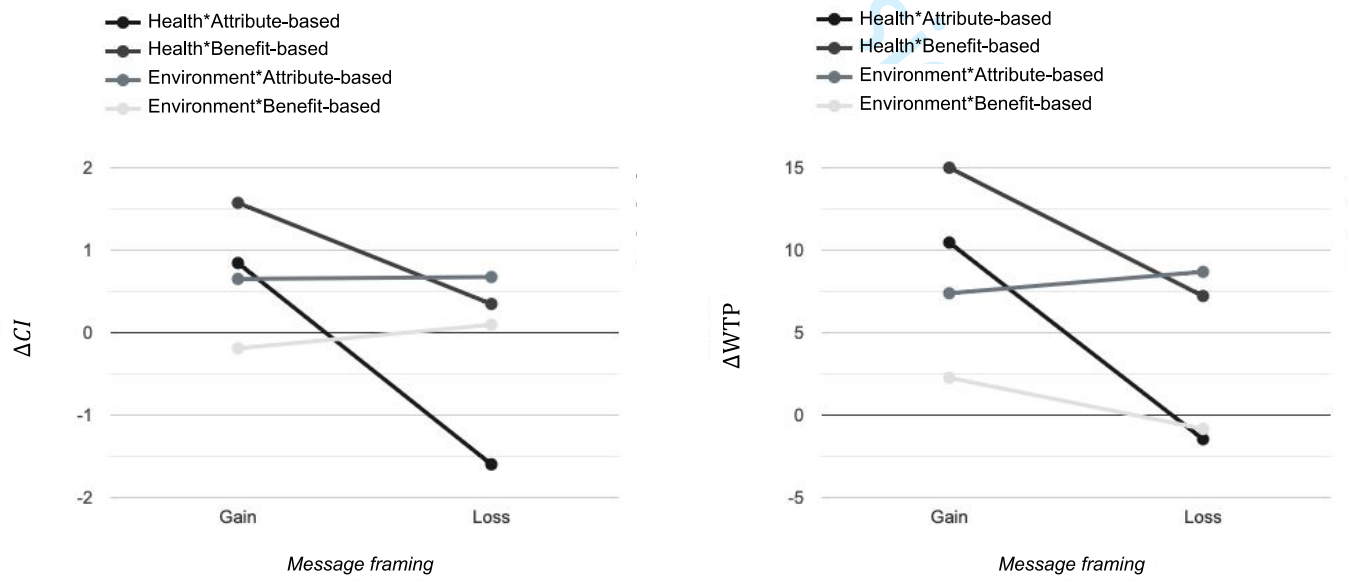


a) Effects of message framing and message information



b) Effects of message information and message description



c) Effects of message framing, message information, and message description

Figure 3. Interaction effects between message framing, message information, and message description

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Supplementary Table 1. Sample profile

Demographic characteristics	Total (n = 361)	Message 1 (n = 43)	Message 2 (n = 48)	Message 3 (n = 47)	Message 4 (n = 45)	Message 5 (n = 46)	Message 6 (n = 42)	Message 7 (n = 42)	Message 8 (n = 48)	Ch-square analysis/One-way ANOVA
Gender										0.658^{ns}
Male	122 (33.8%)	15 (34.9%)	17 (35.4%)	16 (34.0%)	14 (31.1%)	14 (30.4%)	12 (28.6%)	20 (47.6%)	14 (29.2%)	
Female	239 (66.2%)	28 (65.1%)	31 (64.6%)	31 (66.0%)	31 (68.9%)	32 (69.6%)	30 (71.4%)	22 (52.4%)	34 (70.8%)	
Average age	30.1	30.9	30.6	30.0	28.1	28.6	28.6	35.0	29.3	0.080^{ns}
Place of residence										0.885^{ns}
Hong Kong & Macau	189 (53.3%)	22 (48.8%)	25 (52.1%)	23 (48.9%)	23 (51.1%)	23 (50.0%)	25 (59.5%)	24 (57.1%)	24 (50.0%)	
Mainland China	158 (43.8%)	19 (44.2%)	19 (39.6%)	23 (48.9%)	20 (44.4%)	22 (47.8%)	17 (40.5%)	17 (40.5%)	21 (43.8%)	
Taiwan	14 (3.9%)	2 (4.7%)	4 (8.3%)	1 (2.1%)	2 (4.4%)	1 (2.2%)	0 (0.0%)	1 (2.4%)	3 (6.3%)	
Highest education level										0.224^{ns}
Primary	2 (0.6%)	0 (0.0%)	1 (2.1%)	1 (2.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Secondary	25 (7.0%)	0 (0.0%)	2 (4.2%)	6 (12.8%)	4 (8.9%)	3 (6.5%)	2 (4.8%)	6 (14.8%)	2 (4.2%)	
Post-secondary	32 (9.0%)	2 (4.7%)	5 (10.4%)	6 (12.8%)	4 (8.9%)	4 (8.7%)	7 (16.7%)	2 (4.8%)	2 (4.2%)	
Bachelor's degree	172 (47.6%)	25 (58.1%)	24 (50.0%)	16 (34.0%)	16 (46.7%)	21 (45.7%)	20 (47.6%)	14 (33.3%)	31 (64.6%)	
Master's degree or above	130 (36.0%)	16 (37.2%)	16 (33.3%)	18 (38.3%)	45 (35.6%)	18 (39.1%)	13 (31.0%)	20 (47.6%)	13 (27.1%)	
Monthly income level										0.140^{ns}
<USD$1,913	203 (56.2%)	23 (53.5%)	24 (50.0%)	26 (55.3%)	30 (66.7%)	29 (63.0%)	25 (59.5%)	16 (38.1%)	30 (62.5%)	
USD$1,913–USD$3,825	65 (18.0%)	8 (18.6)	19 (39.6%)	6 (12.8%)	4 (8.9%)	6 (13.0%)	5 (11.9%)	10 (23.8%)	7 (14.6%)	
USD$3,826–USD$5,737	41 (11.4%)	6 (14.0%)	2 (4.2%)	5 (10.6%)	4 (8.9%)	8 (17.4%)	5 (11.9%)	5 (11.9%)	6 (12.5%)	
USD$5,738–USD$7,650	20 (5.5%)	3 (7.0%)	1 (2.1%)	4 (8.5%)	2 (4.4%)	2 (4.3%)	1 (2.4%)	4 (9.5%)	3 (6.3%)	
USD$9,651–USD$10,838	12 (3.3%)	1 (2.3%)	0 (0.0%)	2 (4.3%)	2 (4.4%)	0 (0.0%)	2 (4.8%)	4 (9.5%)	1 (2.1%)	
>USD$10,838	20 (5.5%)	2 (4.7%)	2 (4.2%)	4 (8.5%)	3 (6.7%)	1 (2.2%)	4 (9.5%)	3 (7.1%)	1 (2.1%)	
Weekly number of vegetarian meals	3.3	2.9	3.8	2.6	3.1	2.9	3.9	3.3	3.8	0.915^{ns}

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Supplementary Table 2. Effectiveness of changing respondents' CI and $WTP

Observations	*n*	CI			$WTP		
		CI_{before}	CI_{after}	*t*	$\$WTP_{before}$	$\$WTP_{after}$	*t*
Main effect of framed messages							
Eight framed messages	361	4.252	4.546	4.346***	24.848	30.859	8.516***
Types of framed messages							
Gain-framed	179	4.175	4.920	7.924***	24.274	32.793	8.045***
Loss-framed	182	4.328	4.178	-1.731^{ns}	25.412	28.956	4.013***
Health-related information	183	4.308	4.587	2.460**	26.011	33.716	7.351***
Environment-related information	178	4.195	4.504	4.260***	23.652	27.921	4.603***
Attribute-based description	181	4.217	4.702	5.758***	23.398	29.420	5.866***
Benefit-based description	180	4.287	4.389	0.978^{ns}	26.306	32.306	6.175***

Notes. ***$p < 0.001$; ** $p < 0.005$; * $p < 0.05$; ^{ns} $p > 0.05$.

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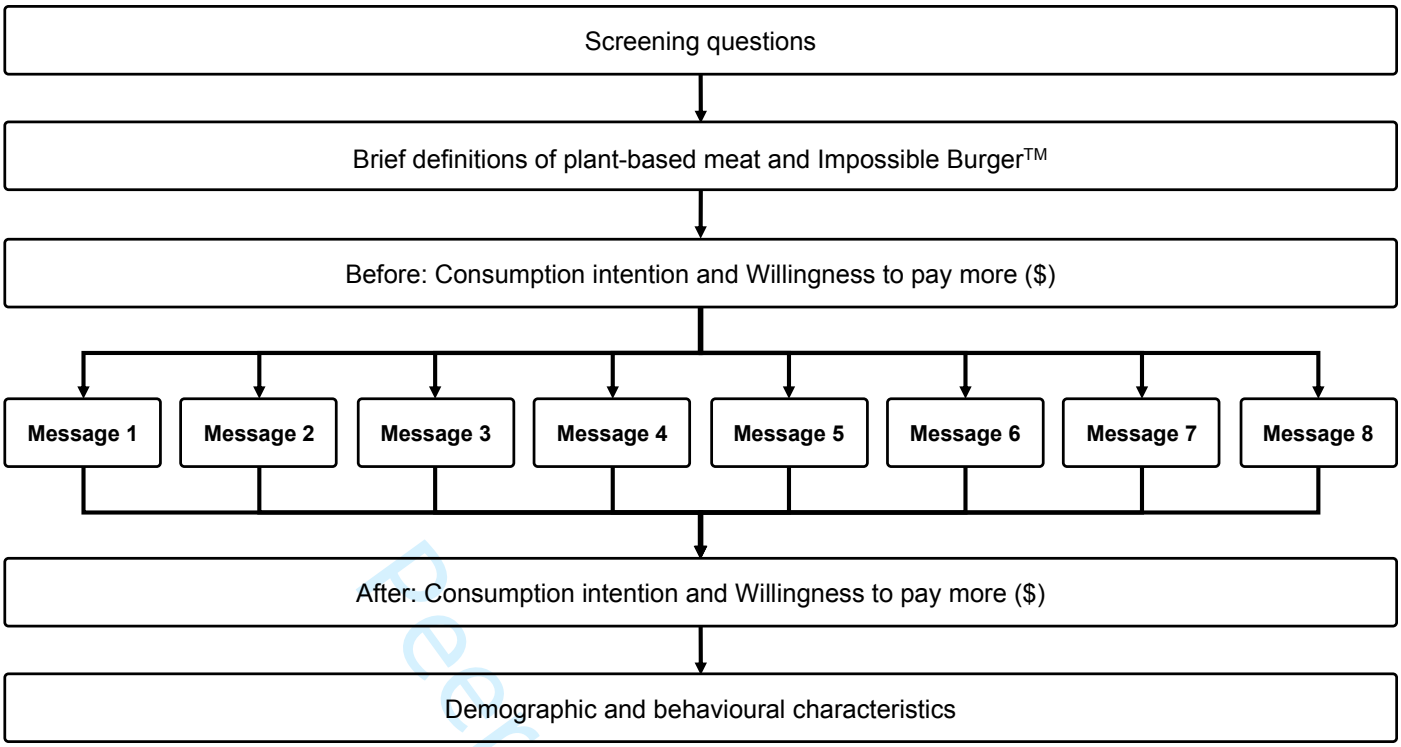

Supplementary Figure 1. Research design

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