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ORIGINAL EMPIRICAL RESEARCH

How lack of knowledge on emissions and psychological biases deter consumers from taking effective action to mitigate climate change

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Abstract

In this research, we document knowledge gaps between consumers and experts about what consumer actions most effectively help mitigate climate change. We then identify three sources for lack of consumer knowledge on greenhouse gas emissions associated with consumption: carbon emissions labeling, awareness of indirect versus direct emissions, and orders of magnitude differences in carbon intensity across behaviors. We further propose that this lack of knowledge and several cognitive and motivational biases lead consumers away from effective climate actions, including the tendency to focus on first- versus second-order effects of "green" behaviors, motivated reasoning that easier, more accessible actions are more impactful, and a focus on individual behavior versus systemic changes. We close with a research agenda designed to address the lack of knowledge and biases we identify, while acknowledging that shifting marketers and consumers to focus on systemic changes may be both most challenging and most impactful.

Keywords Climate change · Responsibilization · Recycling · Sustainability · Emissions · Carbon footprint

Climate change refers to the long-term change in temperature and average weather patterns due primarily to emissions of greenhouse gases (GHG) stemming from human activities. GHGs include carbon dioxide (CO_2), methane, nitrous oxide, and fluorinated gases that trap heat and warm the planet. Human activities related to consumption generate these emissions that change the climate, creating significant impact on such varied outcomes as food production, population movement, and human mental and physical health, among others. Since some GHGs have higher or faster global warming potential than others, it is common practice to express emissions in units equivalent to carbon dioxide (CO_2), the primary GHG emitted through human activities (accounting for 79% of all U.S. GHG emissions from human activities in 2021; EPA 2023). The importance of mitigating climate change by taking action to reduce GHG emissions from human activities is recognized in Goal 13: Climate Action, of the United Nation's 17 Sustainable Development Goals (SDGs), to "take urgent action to mitigate climate change and its impacts" (United Nations, 2023). In fact, given that the 17 goals are highly related, addressing the pressing issue of climate change could also simultaneously help accomplish goals related to both human (2: zero hunger, 3: good health and well-being, and 6: clean water and sanitation) and environmental health and safety (11: sustainable cities and communities, 14: life below water, and 15: life on land).[1]

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[1] Just as mitigating climate change could be instrumental in addressing some of the other 16 SDGs, progress on other SDGs could help address the goal of successful climate action (e.g., 7: Affordable and Clean Energy and 12: Responsible Consumption and Production). However, given the interlinkages between SDGs, in some cases progress towards one goal could limit progress towards another (e.g., making progress on 10: Reduced Inequalities could result in greater consumption, increasing climate emissions and reducing progress on 13: Climate Action).

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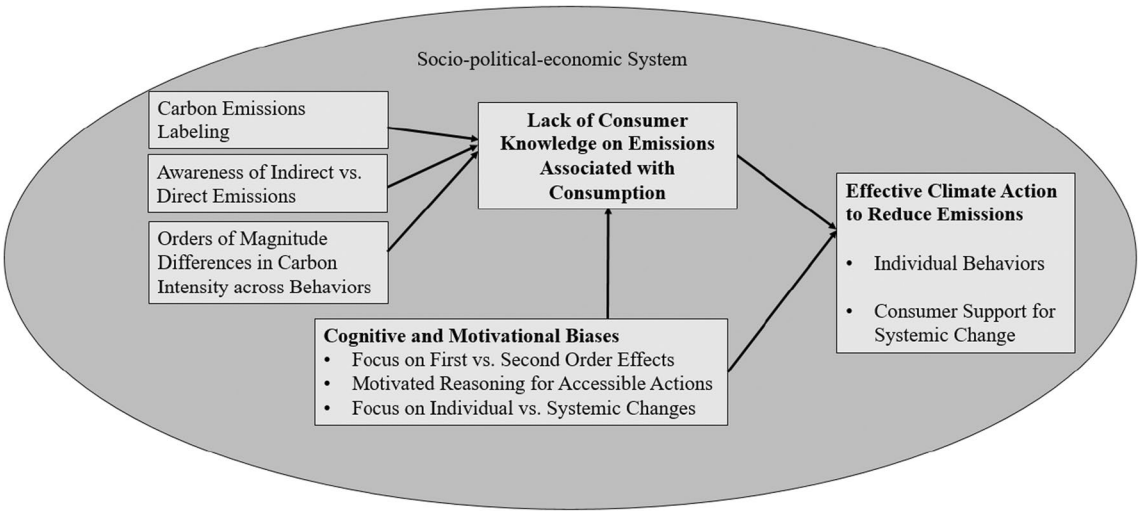

Fig. 1 Conceptual model of barriers to consumers taking effective action to reduce emissions with the goal of mitigating climate change

In line with the UN's recognition of the importance of taking action to mitigate climate change, more consumers have recently become concerned about climate change and seek to reduce the emissions stemming from their personal consumption choices. However, it is unclear if consumers know *which* actions are most efficacious and whether they have the agency to act on this knowledge. For several decades, marketing has focused on changes in individual consumer behavior, resulting in consumer responsiblization, in which responsibility to deal with harm to the natural environment and drive production and consumption systems towards sustainability is placed on individual consumers (Akenji, 2014; Giesler & Veresiu, 2014). While behaviors like recycling have been emphasized, recycling in and of itself is not particularly effective, not only because collection rates are low, but also because of limited uptake/use of recycled content (Geyer et al., 2016). Recycling may also have negative spillovers, crowding out other pro-environmental behaviors and leading to moral licensing (Qi & Roe, 2017; Tiefenbeck et al., 2013). In addition, consumers may believe they can do their part to fight climate change by buying "green" products. However, green consumerism does not necessarily meaningfully mitigate climate change, as consumers often consume more when using more efficient products, attenuating any material or energy savings and even increasing overall material and energy use (Akenji, 2014; see also Font Vivanco et al., 2022 for a review on such rebound effects). Other individual consumption choices that could have more meaningful impact on mitigating climate change (e.g., using public transit or simply buying less) have historically been underemphasized.

In this research, we first document the knowledge gaps that exist between consumers and climate change experts about what marketplace behaviors can effectively reduce emissions to mitigate climate change. We then identify three sources for the lack of consumer knowledge on emissions associated with consumption, which we propose directly affect the consumer's ability to identify and take effective actions aimed at reducing emissions: carbon emissions labeling in the marketplace, awareness of indirect versus direct emissions, and an understanding of orders of magnitude difference in carbon intensity across behaviors. We further propose that consumers are subject to several cognitive and motivational biases that can lead them away from the most effective emission reduction behaviors, both directly and by contributing to their lack of knowledge about emissions (see Fig. 1 for a conceptual model depicting this process). We review three such processes: a tendency to focus on first-order versus second-order effects of sustainable behaviors, motivated reasoning that easier and more accessible actions are more impactful, and a tendency to focus on individual versus systemic changes. The last of these is perhaps most critical, as there is growing consensus that the individual choices of the most environmentally conscious and well-educated consumers cannot have the magnitude of impact necessary to mitigate climate change; more systemic changes are needed (Chater & Loewenstein, 2023). We therefore close with a research agenda designed to address lack of knowledge and the biases we identify, while acknowledging that shifting marketers and consumers to focus on systemic change may be both most challenging and most impactful.

Survey of layperson versus expert beliefs about the impact of consumer behaviors to mitigate climate change

While not all consumers are motivated to reduce their emissions, an increasing number are. In a 2022 global consumer survey, nearly half (46%) of consumers named climate change as one of their top three environmental concerns (Mintel, 2022). Such concerns are particularly prominent among Millennial and Gen Z consumers, for some of whom concern about the planet's

future has turned into anxiety (Crandon et al., 2022). It is well-established that consumer attitudes do not consistently predict behavior, which is particularly true for environmental behaviors (Prothero et al., 2011). However, assuming some consumers are ready to act to reduce the emissions associated with their own consumption, how do such consumers know which behaviors are effective in reducing emissions? To examine the extent to which expert knowledge about impactful climate change mitigation behaviors by consumers aligns with the beliefs of lay people, we surveyed three samples.

To compare the beliefs of lay people to those of experts, we conducted three separate online surveys of: (1) 100 U.S. participants on the crowdsourcing platform Mturk, (2) 351 U.S. undergraduate students, and (3) 121 international climate change experts.[2] In the survey, all participants were shown a list of 24 randomly presented behaviors. They were asked, "To the best of your knowledge, please indicate how impactful each behavior is at reducing climate change," where 1 = Not at all impactful and 9 = Very impactful. Following these evaluations, participants were asked, "Assuming climate change is happening, do you think it is…" 1 = caused mostly by human activities, 2 = caused mostly by natural changes in the environment, 3 = none of the above because climate change isn't happening, 4 = Don't know, and 5 = other, please specify (Yale Climate Change Communication, 2023).[3] All participants then provided demographic information.

To analyze the survey responses, we conducted an ANOVA for each behavior with the perceived impact of the behavior as the dependent variable and the sample as the independent variable. The mean impact for each sample is reported in Table 1 with significant differences noted with superscripts. There was a significant effect of sample type on perceived impact for 20 of the 24 behaviors. In the majority of cases, U.S. undergraduate students and Mturk participants perceived behaviors to be more impactful than experts. Consistent with consumer responsibalization (Akenji, 2014; Giesler & Veresiu, 2014), this was particularly the case for common consumer behaviors such as recycling plastic, using reusable water bottles, purchasing organic or eco-friendly products, and purchasing new sustainable clothing. These lay perceptions have likely arisen because companies have invested extensive effort to promote such individual-level behaviors as beneficial, and they allow for consumers to continue consuming with little disruption to their current lifestyle while supposedly overcoming the negative impact of consumption via these "green" purchases or disposal behaviors. However, the impact of these behaviors is often minimal, having a negligible impact on mitigating climate change.

Table 2 shows the behaviors ranked as most impactful by each sample. While there was some overlap in the top six most impactful behaviors between experts and lay people (e.g., using renewable energy, taking public transportation or biking or walking, retrofitting home to be energy efficient), there were also notable differences. Specifically, both the student and adult lay person sample indicated that recycling plastics was among the most impactful behaviors while experts did not. Recycling has been marketed as holding much promise to reduce environmental impact, but the actual impact of recycling rarely equates to the perceived impact (Geyer et al., 2016). For some materials, such as aluminum, whose production is carbon intensive and which can be efficiently recycled repeatedly, recycling offers clear environmental benefits. However, for many other materials, such as plastics or textiles, there is far less impact (Zink & Geyer, 2019). Despite major investments in infrastructure and education, only a small portion of the plastic and textiles produced globally is actually recycled, with far more ending up in landfills (9% for plastics and 12% for clothing: Geyer et al., 2017). Beyond the technical limits to what can be recycled, there are also significant losses in the recycling process. For example, for every one ton of pure cotton textile sent for recycling in Europe, only 250 kg of spinnable recycled fiber is produced under the best-case scenario, and the market for this recycled product is not guaranteed (Duhoux et al., 2021). Yet, consumers are not aware of the nuances in these processes and thus cannot accurately assess the impact of their behaviors.

In addition, the student and lay person sample seemed to underestimate the potential climate benefits of reducing red meat consumption, while experts noted this as one of the most impactful activities, consistent with prior research (Ivanova et al., 2020). This difference points to a knowledge gap and suggests that the general U.S. population might not be aware that a shift to a more plant-based diet is one of the most impactful activities they can engage in at the household level (Eshel et al., 2014; Sun et al., 2022). Estimates suggest that adopting a vegetarian diet could reduce annual per capita emissions by close to 1t of CO_2e (Ivanova et al., 2020).

There are also differences among the student and adult samples in the top-rated behaviors, likely driven by the accessibility of these behaviors due to how frequently they are encountered. Notably, undergraduates in the U.S.

[2] This sample was recruited through a combination of sustainability and climate change research listservs with which the three authors had contacts. The starting point was a Research Coordination Network on the Digital Economy and the Environment organized by the National Science Foundation, of which the second and third authors were members. After the survey was sent to this organization, all three authors sent it to listservs for sustainability researchers either at their university or external listservs of which they were members. Because the expert listservs allowed us to capture responses from over a dozen countries, the expert sample is global while the two lay person samples are comprised of U.S. respondents. However, the majority (51%) of expert participants were from the U.S. See the Appendix for additional demographic detail on all three samples.

[3] The majority of respondents in each group indicated that climate change is caused mostly by human activities (95% of experts, 84% of students, and 75% of Mturk participants).

Table 1 Mean ratings for mitigation of climate change by sample

	Climate Change Experts	Undergraduate Students in the U.S	U.S. Adults on Mturk
Food			
Eat less red meat	***6.57***^{a}	***4.62***^{b}	***5.95***^{c}
Eat fewer dairy products	5.36^{a}	4.13^{b}	5.22^{a}
Eat less poultry	4.55^{a}	4.11^{b}	5.49^{c}
Waste less food	**5.95**^{a}	**6.20**^{ab}	**6.58**^{b}
Average of food behaviors	5.61^{a}	4.76^{b}	5.81^{a}
Energy			
Use renewable energy (e.g., solar, wind) to power your home	7.16^{a}	7.43^{a}	7.06^{a}
Retrofit your home to be energy-efficient (insulation, windows)	6.98^{a}	6.86^{a}	6.70^{a}
Use energy-efficient appliances in your home	**5.70**^{a}	**6.79**^{b}	**6.56**^{b}
Downsize your home (home has less square footage per person)	***6.58***^{a}	***4.67***^{b}	***5.61***^{c}
Use LED lightbulbs in your home	**5.10**^{a}	**5.43**^{a}	**6.24**^{b}
Average of energy behaviors	6.30^{a}	6.24^{a}	6.43^{a}
Transportation			
Take fewer flights	***7.24***^{a}	***6.07***^{b}	***6.67***^{c}
Take public transportation (or bike or walk) as primary mode of transportation	7.15^{a}	7.05^{a}	6.73^{a}
Drive an electric vehicle as your primary mode of transportation	**5.27**^{a}	**6.34**^{b}	**6.05**^{b}
Carpool as your primary mode of transportation	**5.66**^{a}	**6.35**^{b}	**6.53**^{b}
Buy a small car instead of an SUV or truck	5.90^{a}	5.77^{ab}	6.36^{ac}
Average of transportation behaviors	6.25^{a}	6.32^{a}	6.47^{a}
Other Consumption Choices			
Recycle plastics	**4.09**^{a}	**6.93**^{b}	**6.66**^{b}
Buy "eco-friendly" products	**4.32**^{a}	**6.25**^{b}	**6.24**^{b}
Purchase organic products	**4.05**^{a}	**4.59**^{b}	**4.97**^{b}
Buy second-hand clothing	**5.06**^{a}	**5.76**^{b}	**5.67**^{b}
Buy less clothing	5.48^{a}	5.46^{a}	5.45^{a}
Buy sustainable new clothing	**4.10**^{a}	**5.66**^{b}	**5.60**^{b}
Use aluminum reusable water bottle instead of plastic bottles	**4.54**^{a}	**7.07**^{b}	**6.65**^{c}
Use reusable grocery bags	**3.89**^{a}	**6.61**^{b}	**6.24**^{b}
Plant trees	**5.90**^{a}	**7.10**^{b}	**7.05**^{b}
Write fewer emails	2.75^{a}	1.93^{b}	2.51^{a}
Average of other consumption choices	**4.41**^{a}	**5.73**^{b}	**5.70**^{b}

Bold text indicates a significant effect of sample. Different superscripts denote a significant ($p < .05$) difference between samples. Italics indicates experts perceive greater impact than laypeople

Table 2 Top six behaviors rated as most effective for mitigating climate change by sample

Rank Order	Climate Change Experts	Undergraduate Students in the U.S	U.S. Adults on Mturk
1	Take fewer flights	Use renewable energy to power your home	Use renewable energy to power your home
2	Use renewable energy to power your home	Plant trees	Plant trees
3	Take public transport, bike, or walk	Use aluminum reusable water bottle instead of disposable plastic bottles	Take public transport, bike, or walk
4	Retrofit your home to be more energy efficient	Take public transport, bike, or walk	Retrofit your home to be more energy efficient
5	Downsize your home	Recycle plastics	Take fewer flights
6	Eat less red meat	Retrofit your home to be more energy efficient	Recycle plastics

perceived using reusable water bottles as highly impactful, presumably due to this being a frequent, highly visible behavior at the large public university campus where this study was conducted. In contrast, the Mturk sample of U.S. adult consumers rated taking fewer flights as highly impactful in line with experts, whereas undergraduates did not perceive taking fewer flights to be as impactful.

Looking at the average ratings for each category, there is no difference by sample for the impact of food, energy, and transportation, which suggests that consumers do believe changing food consumption, transportation, and energy consumption behaviors can have an impact. However, lay people do not differentiate the impact among the various behaviors in each category to the same extent as experts. For example, using energy-efficient appliances does not have nearly as much impact on reducing emissions as reducing total home size, which experts recognize but non-experts do not. The only category for which experts and the consumer samples differed across all actions is everyday consumer choices. This supports the notion that consumers have been responsibilized by companies to think these behaviors are impactful even though they are some of the least impactful ways to reduce emissions.

The results of these three surveys provide evidence that there are indeed knowledge gaps between lay people in the U.S. and a group of international climate change experts about the most impactful behaviors to mitigate climate change. These gaps hint at the consumer psychology that impacts consumers' beliefs about how effective various actions are at mitigating climate change. In the next section, we highlight three conceptual drivers of the knowledge gap consumers show in this survey relative to experts.[4]

Sources for the lack of consumer knowledge on emissions associated with consumption

We propose that some of the inconsistencies we observe between experts and lay people are due to gaps in objective knowledge. We next discuss what we believe are three sources for this lack of knowledge on emissions associated with consumption: carbon emissions labeling in the marketplace, awareness of indirect versus direct emissions, and understanding of orders of magnitude differences in carbon intensity across behaviors.

Carbon emissions labeling in the marketplace

There is relatively little information in the marketplace regarding the carbon emissions[5] associated with a given behavior, particularly relative to other alternatives. This is especially true when purchasing consumer products. While consumers can easily compare whether a given food product has more calories, fat, sodium, or protein than an alternative, they cannot easily determine whether the carbon footprint is larger or smaller, as carbon labelling remains relatively uncommon. In 2020, Quorn introduced carbon labelling on its products (Smithers, 2020), and other brands have started providing similar information (e.g., Panera labels some menu options as "cool foods" due to lower carbon footprints; Rybak et al., 2023). Such initiatives hold promise, but it is not clear how these labels are interpreted by consumers (Taufique et al., 2019), particularly when only a few products have such labels and when many consumers exhibit carbon innumeracy (Grinstein et al., 2018).

A review of the carbon labeling literature from 2011 to 2020 found that consumers are generally unfamiliar with carbon labeling and do not have the knowledge to understand carbon measurements and labels (Rondoni & Grasso, 2021). Researchers have begun to identify the types of labels consumers prefer and that are most easily understood; for example, consumers prefer carbon labels that provide comparative information (Hartikainen et al., 2014). Labels that use consumer friendly symbols (e.g., traffic light colors) significantly increase consumer understanding (Rondoni & Grasso, 2021) and can reduce food related carbon emissions (Stillman et al., 2023). However, initial research regarding the use of carbon labels on supermarket owned brand products showed that such labels did not discernably impact demand for lower carbon products based on loyalty card data (Hornibrook et al., 2013), and the impact of carbon labels on willingness to pay is lower than that for other labels such as organic or Fair Trade (Rondoni & Grasso, 2021). Further, firms may be reluctant to add such labels, as consumers may have a negative rather than favorable response to such information (Petersen et al., 2021), and it can be difficult and costly to obtain the information to generate reliable carbon labels, resulting in uncertain or inaccurate labeling.

Even when carbon emissions labels are accurate, they can still result in consumer confusion, as consumers may make other inferences from such labels that are inaccurate. Research finds that consumers often conflate environmental labeling with other attributes (Chernev & Blair, 2021;

[4] We acknowledge that the expert ratings in our survey are subjective and not necessarily representative of the objective impact of each behavior. While expert ratings are arguably closer to the objective impact than that of lay people, there is nuance in the impact of each behavior that is not captured by these ratings. For example, when measuring the perceived impact of different modes of transportation, we did not account for the distance respondents travel each day. The impact of each behavior would vary if one has a five versus 60 mile commute.

[5] Carbon emissions are commonly used in consumer messaging regarding emissions in the marketplace and media (e.g., carbon footprint, carbon labels). Thus, we refer to carbon emissions in this section.

Schuldt et al., 2012). For example, if a product is said to be made with recycled material, consumers may infer the product was made with lower emissions, which is not necessarily the case. Marketers may also engage in greenwashing with either intentionally misleading claims about emissions (e.g., Volkswagon's emission scandal; EPA, 2022) or vague "green" product claims that either intentionally or unintentionally lead consumers to infer a product has stronger environmental performance relative to its counterparts than it does. We argue that the proliferation of labels due to a lack of standardization or regulation and the limited number of accurate labels combined with extensive greenwashing and incorrect consumer inferences have resulted in an information environment in which consumers are unsure of the carbon impact of their purchases. As a result, consumers appear to perceive some behaviors as more impactful at mitigating climate change than they are (e.g., buying products vaguely marketed as sustainable) and others as less impactful than they truly are (e.g., eating less red meat), as seen in our survey.

Awareness of indirect versus direct emissions

Consumers tend to be more knowledgeable about the direct emissions associated with the consumption of a particular product or activity (e.g., fuel burned while driving or flying) than the indirect or embedded emissions emitted upstream in the production of goods and services (Druckman & Jackson, 2009). Indirect emissions are those related to the energy and materials required to attain raw materials, produce, and distribute a product (e.g., emissions related to manufacturing a car and transporting it to the dealership where it will be sold), while direct emissions are those that occur as the product is used by the consumer (e.g., emissions related to fuel consumption and maintenance). In the case of internal combustion engine vehicles, most emissions over the course of the product lifespan are related to burning gasoline and are thus considered direct emissions. However, for an electric vehicle charged with renewable energy or other products such as furniture or consumer electronics like smartphones, the majority of emissions are generally indirect, from raw materials acquisition and processing, production, and transportation, as well as disposition (Makov & Fitzpatrick, 2021). Though consumers may have an intuitive understanding that upstream stages generate emissions, they might not realize their magnitude and focus instead on direct emissions, although most of the emissions associated with household consumption are indirect rather than direct (Ivanova et al., 2020).

This knowledge gap regarding indirect emissions has consequences on consumer's choice when seeking climate friendly options. Consumers may infer, for example, that foods that are locally produced have lower emissions compared with imported foods since they require less transport. However, since food production tends to be far more carbon intensive than its transport, food miles are not a good proxy for emissions impact; instead, it is the production system and, more importantly, the type of food that most affects its carbon footprint (Gupta & Makov, 2017; Sun et al., 2022). Red meat, for example, is disproportionally carbon intensive, not only compared to plant-based foods but also in comparison with other animal-based products such as chicken (Eshel et al., 2014).

Further underscoring a lack of understanding of indirect emissions, consumers have rallied around the cause of reducing plastic waste, likely due to its salience as well as the fact that it is derived from fossil fuels. Though the human health and planetary health impacts of single-use plastic are undeniable (Miller, 2020), a single-minded focus on reducing single-use plastic can cause unintended consequences if a holistic, life-cycle approach that accounts for indirect emissions of alternatives is not considered. As a simple example, it takes far greater resources (and emissions) to produce a reusable water bottle than a disposable plastic one. Unless a reusable bottle is used hundreds if not thousands of times before disposal, it will have a larger carbon footprint than a single disposable plastic bottle (Makov et al., 2019). Thus, some well-intended solutions to the single-use plastic problem could inadvertently cause greater damage through problem-shifting toward less visible environmental impacts, or indirect emissions. The same applies to reusable shopping bags, more durable apparel, or consumer electronics, and even electronic books (e.g., Kindle), which are preferable to their disposable counterparts only if they are used hundreds of times and their use displaces hundreds of new single use products (Makov et al., 2019).

Orders of magnitude differences in carbon intensity across behaviors

Just as consumers may not realize how high the total emissions for a given product may be due to indirect emissions across its life cycle, consumers also often do not understand that the carbon impact of different behaviors can be a different order of magnitude across consumption categories. To illustrate, the climate change impact associated with a flight from New York to Los Angeles in economy class amounts to roughly 1.5 metric tons of CO_2e (when including the

climate change impacts of radiative forcing[6]; UK Government, 2022). This is notable, as recent estimates suggest that annual per capita emissions must drop to 2.8tCO_2e or lower (for a population of 8.5 billion by 2030) to remain within 1.5 °C of global warming (Ivanova et al., 2020; O'Neill et al., 2018).[7] Failing to engage in several sustainable household behaviors such as recycling and using a reusable water bottle for a full year would not equal the same magnitude of emissions as foregoing a single flight. For such behaviors, it is critical to increase consumer knowledge that a one-time action can have a substantial impact on reducing emissions and mitigating climate change. In other words, rather than investing resources in encouraging consumer recycling (Winterich et al., 2019), it would have a far greater impact if the same investments were made in encouraging consumers to engage in more impactful behaviors like flying less or retrofitting their homes for energy efficiency.

At the same time, consumers should recognize the magnitude of impact they can have when consistently engaging in more impactful behaviors at the household level. If a consumer has red meat for one meal per day, consistently replacing this daily red meat with a plant-based substitute could have a larger magnitude of impact, approaching that of a flight, when this is done for an entire year.[8] While such choices could be implemented at the household level, there is also room for choice editing by institutions (e.g., cafeterias, schools, universities, etc.), which could help facilitate wide scale adoption of such shifts (Reisch & Sunstein, 2021). As an example of such choice editing, LinkedIn recently shifted to a 65% plant-based menu in its San Francisco office as part of its goal to reach carbon-neutrality by 2030 (Starostinetskaya, 2023).

Cognitive and motivational biases that affect consumer knowledge on emissions associated with consumption and decision making about actions to reduce emissions

In the preceding section, we discussed objective knowledge that many consumers are lacking about the emissions associated with various consumption activities. In addition to consumers making factual errors in deciding which actions are most effective at reducing emissions due to this lack of knowledge, we propose that consumers are also subject to several cognitive and motivational biases that can lead them away from the most effective climate mitigation behaviors, both by directly impacting their choices and by influencing their knowledge of emissions associated with consumption.

Focus on first- versus second-order effects of "green" behaviors

Similar to how consumers may not understand indirect emissions across the entire life cycle, consumers also have a bias to focus on the first-order effects (or the direct consequences) of a particular "green" marketplace action like buying packaging-free fresh produce (instead of the more typical plastic wrapped products). First-order effects, in this case, would include using less plastic packaging. However, it is critical to also consider the second order effects of the initial consequence. Second and subsequent-order consequences are the system wide, longer-term effects of a decision. Since packaging can prolong the shelf life of fresh produce, buying packaging-free groceries may result in more food waste, and, since it is more carbon intensive to produce food than packaging, such shifts may ultimately increase rather than decrease emissions. Specific second-order effects that consumers may overlook in the domain of climate change include rebound and licensing effects that follow a behavior or choice intended to reduce emissions.

Originating in the field of energy economics, rebound effects include a variety of behavioral and systemic responses to efficiency improvements that counteract, to some extent, the expected environmental benefits delivered by more energy efficient technology/products when introduced (Font Vivanco et al., 2022). Put simply, this means that a 50% increase in a products' energy efficiency does not always lead to a 50% reduction in energy consumption. Well-documented examples of rebound effects include people driving more after buying more fuel-efficient cars (Gillingham, 2020) or setting thermostats to higher indoor temperatures following installment of more efficient heating systems.

Research in consumer behavior and behavioral economics has expanded the concept of rebound to encompass so-called sociopsychological or mental rebound effects (Santarius & Soland, 2018; see Font Vivanco et al., 2022 for a review). The main reasoning behind mental rebound is that consumption patterns have a normative basis, which defines their acceptable financial, social, and environmental costs. When the environmental cost of a product or service drops, consumers might feel that they have a "moral license" to consume more of it (Tiefenbeck et al., 2013). An owner of an electric vehicle, for example, might feel entitled to environmentally-unfriendly behavior, such as buying an additional car for longer trips (Santarius & Soland, 2018). Consumers may generate more food waste when they know their

[6] Assuming 3974 km one way, at 0.193 kgCO_2e per passenger-km.

[7] This would be a significant reduction from the current estimated 6.8tCO_2e per person in the EU as of 2019 (Eurostat 2022).

[8] 3.7 kg CO_2e to produce a quarter pound beef patty/burger on average vs. 0.4 kg CO_2e for a plant-based burger by Beyond meat = 3.3 kg CO_2e × 365 days/year = 1.2t reduction in CO_2e (Heller and Keoleian 2018; Thoma et al., 2017).

leftovers will be composted (Qi & Roe, 2017) and, when purchasing products labeled as environmentally "friendly," consumers may subsequently feel less guilty about their consumption and thus buy more (Barkemeyer et al., 2023). Researchers have even found that the option to recycle can create rebound effects: When a recycling bin was placed in a restroom for paper towels, consumers used more paper towels compared to when there was no recycling bin (Catlin & Wang, 2013). Moreover, if a sustainable product is cheaper than a traditional product offering (e.g., a used iPhone) or otherwise offers cost savings (e.g., more efficient LED lighting), consumers tend to consume more of it (e.g., buying a spare smartphone or leaving the lights on when leaving a room) or spend the savings buying additional products and services. Such re-spending rebound effects can erode some or even all the environmental benefits of the sustainable product option (Makov & Font Vivanco, 2018).

These examples of moral licensing could also spill over from one domain to the other. Tiefenbeck et al. (2013) found that while feedback on water consumption reduced household water use, it led to an increase in energy consumption. Barkemeyer et al. (2023) recently demonstrated that there is a positive relationship between consumers' carbon footprints and their willingness to consume environmentally friendly products. This relationship suggests that consumption of products labeled as "green" may give consumers a moral license to consume more and increase their overall carbon footprint. By ignoring the impact of these second-order effects, consumers may choose actions they think reduce emissions based on the first-order effect but ultimately produce more net emissions. Alternatively, when there is a higher price for less sustainable or socially costly products, some consumers, particularly upper-class consumers, may feel licensed to purchase these less sustainable products because the higher price makes them feel entitled to more resources (Lee & Winterich, 2022).

Motivated reasoning about the impact of easier, more accessible actions

Climate change is a large intractable problem that can evoke negative affect among consumers. Prior work on the coping mechanisms consumers use when faced with issues like harm to the environment suggests that consumers may choose to avoid information about this harm (Ehrich & Irwin, 2005; Zane et al., 2016) or to forget it entirely (Reczek et al., 2018a) to avoid the feelings of guilt and anger the issue may evoke. However, there are other coping mechanisms consumers employ that are more positively valenced. For example, consumers with strong green consumption values rely on motivated reasoning (Kunda, 1990) to infer that green all-purpose cleaners are strong and effective (Haws et al., 2014), in contradiction to the sustainability liability (Luchs et al., 2010). We suggest that consumers may use similarly positively valenced motivated reasoning when thinking about the impact their own actions can have in mitigating climate change.

As a result, we propose that consumers believe that the things they can do to mitigate climate change with relative ease are more impactful than they truly are as a coping mechanism when they cannot do the things that have meaningful impact on reducing emissions either because they are too hard or too costly or both. That is, consumers engage in motivated reasoning to believe that the relatively accessible things they are already doing really matter. For example, using a reusable water bottle rather than disposable plastic water bottles is readily accessible to consumers, both as an action they can easily take and mentally accessible due to the visibility of reusable water bottles in public spaces. Both types of accessibility lead consumers to be motivated to perceive the impact of using a reusable water bottle as greater than it is, just as we saw with the undergraduate sample in our survey. This behavior is particularly problematic, as consumers may focus on a single behavior due to single-action bias (Weber, 1997). That is, by focusing on any one action, even if it is low impact with respect to reducing emissions, consumers tend to discount other actions that may be more impactful. Consumers may also engage in motivated reasoning when their preferred option is not available. For example, consumers may prefer to purchase their beverage by refilling an existing bottle. Yet, if the only option is to purchase it in a plastic bottle, they may be motivated to believe that recycling the plastic is impactful as a coping mechanism. Given this bias toward motivated reasoning, it is even more critical to focus on the few actions with the largest impact and not just those that are convenient, as otherwise consumers may engage in only convenient but less impactful climate actions.

Focus on individual versus systemic changes

Consistent with the lack of knowledge on differences in orders of magnitude of the carbon intensity of various consumption activities, systemic changes can have much greater impact than individual behaviors. Yet, consumers tend to overestimate the impact of individual behaviors on mitigating climate change relative to the impact of systemic change. This overemphasis on individual behaviors likely arose, at least in part, due to consumer responsibilization (Akenji, 2014; Giesler & Veresiu, 2014), in which emphasis has been placed on individual actions to reduce environmental harm, including their own personal emissions. For example, companies have encouraged consumers to recycle plastics for decades but failed to focus on altering the system that relies on production

of single-use plastics. This focus on recycling arose from oil companies, who benefitted from plastic production and opposed system changes, investing in and supporting individual behavior change initiatives to divert attention from system changes (Chater & Loewenstein, 2023). The motivated reasoning bias we identify may also lead to an over-emphasis on individual behavior change, both among individual consumers and the researchers who study it; consumers and researchers alike tend to perceive changes in individual behavior as more easily implementable than systemic changes.

Chater and Loewenstein (2023) refer to the focus on individual behaviors to solve climate change as the i-frame (for individual) and changes to the system in which individuals operate as the s-frame (for system). They call for much-needed systemic reforms after individuals and researchers have unwittingly promoted the i-frame for decades at the interests of companies opposing systemic reform, a call that is starting to be taken up by some marketing scholars (Bolderdijk et al., 2023; Winterich et al., 2023). Public policy is at the core of systemic reform, from taxation to regulations. To be sure, i-frame interventions are not irrelevant; they simply will not have the magnitude of impact that is needed. For example, rather than encouraging consumers to reduce energy use at home by adjusting their thermostat and unplugging devices when not in use, total emission reduction would be much greater if electricity production is decarbonized or company energy use is regulated. However, this shift to framing climate change issues around the system rather than individual behaviors will not be easy to overcome for several reasons.

First, the current framing on individual behaviors makes it more difficult for consumers to access a different mental model that focuses on the system, as our brains tend to be limited to a single mental model in our reasoning (e.g., Johnson-Laird, 1983). A focus on encouraging individuals to change their behavior rather than the system is also consistent with the fundamental attribution error, in which consumers overestimate individual factors and underestimate situational factors (Ross, 1977). Further, the messaging for individuals to change behaviors is crowding out the opportunity for consumers to place responsibility on companies and governments or the system more generally. For example, research shows that if consumers know that individuals can reduce their energy use at home via nudges, they are less likely to support a carbon tax (Hagmann et al., 2019). Moreover, placing responsibility on individuals inherently reduces responsibility on companies, given that responsibility is divisible (Akenji, 2014). Thus, the effort by companies to shift responsibility to consumers decades ago has been fruitful for firms seeking to avoid responsibility and enhanced by individuals and researchers focusing on individual behavior change.

Though there is still a primary focus on individual consumer behaviors, consumers are increasingly expecting companies to address climate change. A majority (65%) of the 10,000 consumers surveyed by Deloitte in January 2020 expected CEOs to do more to make progress on societal issues, including reducing carbon emissions (Deloitte, 2021). Research from the Natural Marketing Institute finds that consumers, particularly those that have a "deep green" consciousness, want to know what companies are doing to reduce their overall environmental impact and, specifically, to prevent global warming and reduce emissions (French, 2023). If consumers are starting to place more responsibility on companies, then they should be inherently reducing the responsibility they place on themselves. While this shift in responsibility may be a way to reduce their own guilt, it may also be an opportunity to gain traction for systemic reform.

A research agenda for addressing lack of consumer knowledge on emissions associated with consumption and the biases that can deter consumers from taking effective climate action

Marketing researchers have a unique role to play in conducting research designed to understand how to shape consumer beliefs and actions about emissions reduction and climate change with our understanding of consumer psychology and the marketplace. We can apply our theory and methods to help inform policy makers, sustainability advocates, businesses, entrepreneurs, and the public about the most effective and practical ways to reduce emissions associated with consumption, overcome common biases, and encourage the adoption of high impact climate change mitigation behaviors. While researchers have started this important work with respect to sustainability (see, for example, White et al., 2019), we propose that the same needs to be done with an eye toward climate change and reducing emissions more specifically (as opposed to generally "greening" consumer behavior). We therefore close with a research agenda designed to address the sources for the lack of consumer knowledge on emissions from consumption (Table 3) and the biases we have identified (Table 4) as impacting effective consumer climate action by articulating specific questions for future research.

Future research addressing consumers' lack of knowledge on emissions from consumption

Carbon emissions labeling One of the most central research questions related to product level carbon labeling is how to provide consumers with specific objective information that is comparable across products. Though it is harder to

Table 3 Emerging research questions related to the three sources of lack of consumer knowledge on emissions associated with consumption

Carbon Emissions Labelling
-What format of emissions information is easiest for consumers to understand? Is this the same format that is most effective at driving purchase of lower emissions products?
-What is the impact of emissions labels relative to other product attributes (e.g., price, nutrition), and what lay theories do consumers have about the relationship between emissions and other valued product attributes?
-How do consumers interpret certifications on labels? Are consumers more likely to buy products with labels that have certifications?
-Do labels with price per year or lifetime costs motivate consumers to purchase more durable products that may be associated with higher indirect emissions but lower emissions over time if used for many years?
-How should carbon emissions labels be standardized to reduce information overload and increase impact on purchase?
Awareness of Direct vs. Indirect Effects
-How can the indirect emissions from hidden processes (e.g., production, end of life management) be made salient to consumers?
-What types of messaging encourage longer use, reuse, repurposing, and reduced purchasing of new products?
-How can the environmentally optimal product lifespan be communicated to consumers to extend product usage duration?
-How can consumers' support for EPR (extended producer responsibility) be encouraged?
-How can consumers help to hold companies accountable for indirect emissions in their operations and motivate companies to reduce such emissions?
Orders of Magnitude Differences
-How can the magnitude of differences in carbon impact across individual behaviors be effectively communicated to consumers?
-How can social norms be used to reduce high carbon impact behaviors?
-How do consumers respond to choice editing of carbon intensive behaviors?
-What motivates consumers to engage in choice editing themselves (e.g., using filters when shopping online)?
-How can marketers help consumers understand which lower impact carbon mitigation behaviors (e.g., shifts to a plant-based diet) are worth doing consistently because doing them repeatedly can match the impact of higher impact behaviors?

Table 4 Emerging research questions related to the cognitive and motivational biases impacting both consumer knowledge of emissions and actions to reduce emissions

First vs. Second Order Effects
-When are consumers most likely to engage in licensing both within and across consumption categories?
-How does licensing occur across stages in the consumption cycle? How can acquisition licensed by sustainable disposition be deterred?
-What can motivate consumers to engage in behavioral consistency rather than licensing?
-Does increased salience of licensing and rebound effects mitigate them?
-How can consumers be educated (motivated) to keep consumption levels constant when upgrading to more sustainable options?
-How can opportunity costs be made salient so consumers move beyond consideration of first order effects and increase climate change mitigation behaviors?
Motivated Reasoning
-Are consumers who care more about climate change more likely to be overly optimistic about the impact of easy to execute actions?
-Conversely, are those who are more pessimistic about climate change less subject to this bias?
-If more impactful but more difficult options are available, how can consumers be motivated to choose them?
-Will the introduction of barriers to currently accessible behaviors shift consumers to harder but more impactful behaviors?
-Can focusing on immediate rewards (e.g., with incentives or via framing) of more difficult but more impactful behaviors be effective at encouraging consumers to engage in less convenient but more impactful actions?
-Will knowledge of the low emissions impact of some common, easily accessible sustainable behaviors decrease consumers' motivation for higher impact behaviors or beliefs in their own self-efficacy to positively impact climate change?
Individual vs. Systemic Changes
-Who do consumers currently perceive as responsible for mitigating climate change (individuals, firms, or governments) and how can these perceptions be shifted?
-Are customers or employees more effective at encouraging companies to implement lower emission infrastructures?
-How can consumers help drive industry-wide change via support for new policies and regulations rather than focusing on a single company?
-Do a company's climate change initiatives spill over to affect individual employees' behaviors? How can policies spur this spill over?
-How can consumer mindsets be shifted to focus on consuming for well-being rather than material wealth?
-Will a top-down or bottom-up approach be more effective in driving regulation and consumer acceptance of emission reduction policies given divergent opinions?

quantify the total emissions in a specific bowl of cereal than it is to calculate the nutritional content of the same, an environmental facts panel similar to the Nutrition Facts Panel in the U.S. should aid in consumer understanding and the ability of consumers to make tradeoffs between price, quality, and climate impact. In addition to labels, a growing number of apps (e.g., Joro, CoolClimate) and web-based carbon calculators (e.g., from the WWF, Nature Conservancy, or UN) have been developed in an attempt to close the consumer knowledge gap as well as nudge consumers towards less carbon intensive choices. While such solutions hold much promise, they are only as good or reliable as the available assessments they draw on, which, as noted previously, are not always accurate or complete.

In part this is because assessing the GHG associated with a specific product or service can be labor intensive and time consuming. Moreover, there is large variance in GHG emissions associated with similar products depending on their specific material composition, manufacturing processes and locations, and supply chain structure. For example, the emissions associated with 1 kg of beef can vary between 10.74–109.5 kg CO2e depending on the location and farming practice (Clune et al., 2017). Thus, while apps and carbon calculators have potential to increase consumer knowledge regarding typical differences in carbon intensity between consumption categories, their ability to enable reliable, direct comparisons between similar items remains limited. The role of comparative information on labels or apps is important for future research to examine, particularly the impact of within versus across category comparisons, since it is more impactful for a consumer to eat lentils in place of red meat rather than choosing a slightly lower emission red meat. Of course, even the federally mandated Nutrition Facts Panel has not mitigated the obesity crisis, so it would be foolish to think a similar emissions facts panel would lead consumers to consistently choose the least harmful option. This is no doubt because consumers have other goals when choosing food beyond just health: goals that they may perceive as conflicting with health such as saving money (Haws & Winterich, 2013) and choosing tasty foods, consistent with research on consumer lay theories about food attributes (Haws et al., 2017; Raghunathan et al., 2006). Future research should address what impact emissions labels have relative to other product attributes (e.g., price, nutrition, taste) and how this impact is shaped by consumer lay theories about the relationship between emissions and other product attributes.

Regardless of what lay theories are identified, clear emissions information would at least give consumers the chance to make more informed choices and would mitigate both intentional and unintentional greenwashing by firms. Future research should also explore what factors, other than legally required labeling, can enhance the credibility and comparability of emissions labels on packaging. The Federal Trade Commission's Green Guides (FTC, 2012) indicate the importance of certification of green claims, but little research has examined the impact of label certification on consumer purchases (see Darnall et al., 2018). If a label contains a certification, do consumers distinguish this from a label that does not have a certification? If so, it may be critical for certifications to be tiered, so consumers can determine which certification is better, but it will also be important to limit the number of different certifications used on labels.

Finally, most carbon emissions labels in the marketplace today tend to report only emissions from production (e.g., carbon emissions on food labels), while other types of labels related to emissions focus only on direct emissions (e.g., energy star rating). Future research can explore how consumers respond to labels that include both direct and indirect emissions (which are typically less salient to consumers in non-food domains). When information about indirect emissions is included, consumers would benefit from knowing how durable the product is to understand if higher indirect emissions are worth it to achieve greater durability (and hence fewer purchases of new products that themselves are associated with indirect emissions). This is because greater durability is often achieved though more durable but more carbon intensive materials and higher production related emissions (Makov et al., 2019). As a result, buying one relatively high emissions product that will last for many years may lower emissions in the long run. Unfortunately, consumers may not recognize this and might avoid options that could create lower emissions over time because they are expensive up front (e.g., luxury fashion, as in Sun et al., 2021) and perceived as higher emissions than other options when not taking durability into account. Future research can address whether labels that incorporate average product lifetime and indicate price per year can encourage purchase of durable goods even when those goods are higher in indirect emissions (Jacobs & Hörisch, 2022), as well as the duration of their usage. Of course, as more carbon emissions information becomes available, it is possible that consumers will experience information overload (Lurie, 2004), negating any benefit of such information. Research should consider the most effective information to convey and format to do so. Once these are established, labels should be optimized and standardized to minimize information overload and increase the impact of such labels on purchasing behavior. A move to standardization would likely require government regulation similar to the Nutrition Facts Panel required by the Food and Drug Administration.

Consideration of indirect emissions In addition to research exploring how consumers respond to labels communicating both direct and indirect emissions, future research is also needed on how to make the processes that create indirect emissions more visible to consumers. For example, consumers often focus on a product's packaging, rather than its production, although the latter is typically far more carbon intensive. This raises the question of how to encourage consumers to focus on the truly impactful stages of a product's lifecycle instead of the most visible ones. One approach might be to focus on labeling that indicates which stage in the product lifecycle is most impactful in terms of emissions so that consumers can make more effective comparisons between brands and products. Research is also needed on how best to help consumers gain fluency in interpreting labels so they understand whether a given emissions number is indicating total indirect emissions across the product's lifecycle or only a subset of emissions from the

most impactful stages of the lifecycle. Eventually, a standard set of metrics will be needed (e.g., emissions associated with production, emissions associated with transport, emissions associated with end-of-life disposal, etc.), much like the standard categories used in the Nutrition Facts Panel, as mentioned earlier.

Moving beyond labeling, research is also needed to understand how to communicate to consumers that longer lifespans and increased duration of use help to spread indirect emissions out over the period of use even if the direct emissions may be higher. Rather than purchasing a nanny camera or ring doorbell, one may be able to repurpose their old smartphone for this use (Makov & Fitzpatrick, 2021). Consumers may begin to recognize such behaviors as pertaining to climate change when the emissions related to these decisions are made salient. Thus, marketers should also explore how consumers can be encouraged to reduce consumption of new products, especially those that have low energy demand during use (e.g., consumer electronics, furniture), as the most efficient product is the one they already own.

However, longer lifespans are not always preferable. There is an environmentally optimal lifespan: the point in time where the environmental benefits of efficiency gains incorporated into newer models (e.g., lower miles per gallon) outweigh the environmental costs of producing the new product (van Nes & Cramer, 2006). Research is needed to examine if and under which conditions information on indirect emissions from production may spur reuse and repurposing due to increased consumer awareness. Developing apps that calculate optimal lifespan according to use intensity and the energy profile of each product and location could go a long way to help consumers make more informed decisions about product replacement.

Finally, better end of life management in general could yield large reductions in emissions. Despite growth in Extended Producer Responsibility (EPR) regulations, consumers do not seem to hold producers accountable when products are not properly managed at end of life. Perhaps a countermove to consumers' responsibilization should be greater support for policies that hold producers accountable for the damages caused by their products after they are no longer in use. Communicating the indirect emissions associated with end of life may be one way to spur consumer support for EPR policies, which is an important avenue for future research. More broadly, future research is needed to understand how to encourage consumers to hold companies accountable for their indirect climate impacts rather than just those that are salient. For example, a bank may install solar panels in its offices and become "net zero" in its facilities, but its real impact with respect to climate change likely stems from its investment portfolio rather than direct energy consumption.

Order of magnitude of differences in carbon intensity across behaviors In addition to messaging regarding indirect (vs. direct) emissions for a given product, it is also critical for researchers to understand how to best educate consumers regarding the magnitude of impact across different behaviors designed to reduce emissions. As our survey demonstrates, consumers know that flying is carbon intensive, but they do not realize how disproportionally impactful it is. Thus, future research is needed for a better understanding of how to craft effective messaging to both educate consumers on the differences in the magnitude of carbon impact of individual behaviors (e.g., flight vs. driving an electric vehicle or recycling) and make high impact behaviors more salient to consumers.

One potential avenue to reduce high impact behaviors that can be explored in future research is through social norms. For example, flight shaming, as evidenced in Sweden, could be effective at mitigating high magnitude behaviors (The Economist, 2019) and highlights how social norms and culture help shape consumers' carbon footprints. For example, the U.S. and the UK are both considered "rich" nations with high levels of GDP, but the average per capita consumption based emission in the U.S. in 2019 was more than double that of the UK (about 17.3t CO_2e vs. 7.7t CO_2e respectively; Ritchie et al., 2020). This finding is consistent with research repeatedly demonstrating considerable variance in carbon footprints per capita across countries with similar affluence levels (Lenzen et al., 2006), which speaks to the moderating role of culture and social norms and how they can influence not only consumers' personal choices and lifestyles, but also the development of low carbon infrastructure systems such as transport and electricity provision (Frank, 2023). Research should test social norms-based interventions to shift consumers away from high impact behaviors and encourage adoption of more sustainable lifestyles (e.g., perhaps through the positioning of a low carbon lifestyle as aspirational). Such social norms-based interventions may be particularly promising as social comparison was found to be one of the most effective types of interventions for climate change mitigation behaviors in a meta-analysis of field interventions (Bergquist et al., 2023).

While choice architecture and nudges can help reduce some high impact behaviors, evidence suggests that their scale-up potential likely falls short of the necessary targets. They might be most impactful when focused on single-use choices (e.g., purchasing a smaller car or electric vehicle) that reduce emissions through repetitive use. Research must also gain a better understanding of how to "sell" choice editing to consumers, which refers to the active process of controlling or limiting the choices available to consumers to drive an end goal (e.g., consumption of less harmful or more sustainable products). In other words, rather than providing consumers a choice, companies may need to edit out the

unsustainable options by no longer offering them. Doing so not only means consumers who do not care about climate change will end up choosing lower emissions options simply because higher emissions options are not available, but also reduces the need for consumers who do care about mitigating emissions to know exactly which options are associated with high emissions in order to make a good decision. When companies choose to remove beef from their menus or offer vegetarian as the default option, this eliminates the need to influence individual consumers and collectively will have a much greater impact (Reisch & Sunstein, 2021). Thus, it is critical for research to study both how organizations can effectively implement choice editing but also what factors motivate consumers to use choice editing for their own decisions, something becoming increasingly feasible when shopping online (e.g., filtering options on Amazon.com to only consider "climate friendly" options).

Future research on biases that influence consumer decisions about effective climate actions

Increasing focus on second order effects Consumers frequently focus on the first-order effects of their actions, such as forgoing disposable plastic when using a reusable water bottle, but fail to consider the second-order effects of the resources needed to produce reusable water bottles and how many times a reusable water bottle should be used before being disposed of, as well as the emissions from cleaning a reusable water bottle. This focus on the first order effect (e.g., forgoing use of plastic) without consideration of second order effects (e.g., frequency of disposing of reusable water bottles) results in consumers engaging in subsequent behaviors (e.g., acquiring many reusable water bottles that are rarely used), which are referred to as licensing or rebound effects, that may have greater net emissions that consumers simply do not consider. While we know such effects are common, there is still relatively limited understanding of when such effects are most likely to occur and what their magnitude will be. To further our understanding of such effects, it is important to consider the contexts in which licensing may occur. It may arise across the consumption cycle, for example, when a "sustainable" choice to recycle old clothing subsequently licenses a consumer to acquire more new clothes than if they had not engaged in sustainable disposition. Such choices may be mitigated if consumers considered the second order effect of the resources to produce new clothes in addition to the first order effect from recycling a clothing item instead of trashing it. At the same time, licensing does not only occur within a single domain, as engaging in a behavior deemed sustainable in one domain may lead consumers to be less sustainable in another domain. For example, consumers may choose to forgo meat for a meal or use a reusable water bottle, but they may subsequently not only feel justified to eat more meat the next day, but also then feel justified in taking an extra flight, buying new clothes, or driving a fuel guzzling SUV. In considering cross-category licensing, research should explore if consumers engage in licensing for a low carbon intensity behavior such that they feel justified to subsequently engage in a high carbon intensity behavior. Such licensing would be concerning given the net increase in emissions, and thus research should seek to identify when licensing occurs, both across stages in the consumption cycle, as well as across consumption domains, to be able to counter it.

On the flip side of understanding licensing is the importance of spurring more consistent behavior, both within and across domains. There is at least some evidence that consumers with strong environmental values engage in consistent behavior, making a second environmental purchase after an initial one (Garvey & Bolton, 2017), but future research is needed to understand what factors increase the likelihood of behavioral consistency and habit formation for low emissions behaviors. Can marketers utilize reward systems to encourage consistency, at least within a single domain, or perhaps collaborate to encourage consistency across domains? Research has found that simple tweaks such as placement of reminder messages can aid in habit formation (Putnam-Farr et al., 2023). Another important question is whether consumers are even aware of licensing and rebound effects and, if not, whether increased awareness would curb the frequency of such effects? While consumers may be at least somewhat aware of licensing effects, they may not be as conscious of re-spending rebound effects. Future research is needed to explore whether marketers can effectively employ messaging during or following purchase that reduces the likelihood of consumers increasing consumption following acquisition of a sustainable option.

One additional avenue to encourage a move beyond the focus on first order effects of climate change mitigation behaviors may be to increase the salience of opportunity costs (Frederick et al., 2009). For example, if a consumer shifts to a plant-based diet, they may only consider the emissions saved from avoided meat production. However, by reducing demand for meat, they are also reducing demand for agricultural land that can then be restored to its natural vegetation which would sequester additional carbon and reduce emissions even more (Hayek et al., 2021). In addition, shifting to a plant-based diet would also improve consumers' health and lower spending on health services (e.g., fewer medications, reduced doctor's appointments; Springmann et al. (2016). If these opportunity costs are made salient, it may help to shift behavior.

Overcoming motivated reasoning While we have proposed that consumers use motivated reasoning to infer that

the actions that are most impactful are those that are both easy to execute and highly accessible due to exposure frequency, empirical research is needed to document whether this is indeed the case. For example, researchers can explore whether those who care the most about their own individual actions making a difference to help mitigate climate change are more subject to this bias. Interestingly, consumers who experience climate anxiety may be less subject to this bias, as they are more pessimistic about the future and may have less effective coping mechanisms but be more accurate as a result. Once researchers identify which consumers are most subject to motivated reasoning (e.g., consumers with high environmental values; Donnelly et al., 2023), additional research should identify how to overcome the bias.

Unfortunately, consumers tend to place greater value on immediate rewards than those in the future, which is referred to as present bias or hyperbolic discounting (Frederick et al., 2002). When it comes to climate change, the consequences seem distant to many (Reczek et al., 2018b), and thus people may favor not taking impactful actions if they are inconvenient, staying focused instead on convenient but unimpactful behaviors. The choice of a consumer to forgo a flight on account of its carbon intensity has an immediate cost while the benefit or reward of this action is uncertain and distant. Extensive research on goal setting and self-regulation has examined such trade-offs between incurring immediate costs or forgoing immediate benefits for distant benefits in the context of physical (e.g., weight loss, exercise) and financial (e.g., savings) health. This research finds that it is important to provide an immediate reward (e.g., a fun workout) for the desired behavior (Woolley & Fishbach, 2016). In the case of mitigating emissions, it may be useful to focus consumers on choosing the most fun activities for a staycation when forgoing travel rather than those that have the least emissions so there is an immediate reward from forgoing plane travel. For example, Burkhardt et al. (2024) demonstrate that households in Texas were motivated to reduce their energy use in response to messages from their utility company explaining that they can save money (thus offering a financial incentive) by doing so during critical peak pricing periods when power generation from fossil-fuel burning plants (vs. renewable energy sources) is highest. Frequently, though, the benefits of a Western consumer forgoing emission intensive behaviors may only benefit an individual surviving in coastal wetlands in another country as opposed to the self. This stands in stark contrast to the long-term benefits of healthy eating or personal savings that have direct benefits to the self. As such, additional research is needed to understand how the trade-offs of an individual's costs and benefits pertain to consumer assessments of the global costs and benefits from emissions.

More broadly, future research is needed to understand what interventions may be effective at encouraging consumers to choose more impactful options with respect to reducing emissions, particularly if these actions are perceived as more difficult or non-normative. A recent large-scale meta-analysis found that social comparison and financial incentives were the most effective interventions with education and feedback being least effective (Bergquist et al., 2023), but social comparison and financial incentives may not be realistic to implement for some of the most pressing behavioral changes. One effective strategy might be removing those options that consumers inaccurately believe are impactful or increasing the barriers to engage in the otherwise easy, accessible behaviors that are low impact. For example, if a university were to stop recycling single-use plastic, would consumers then purchase less single-use plastic when they are denied an easily accessible way to justify purchasing it? Relatedly, if municipalities stopped offering curbside recycling, would consumers choose to engage in more impactful behaviors such as reuse or reducing red meat consumption?

Finally, perhaps the single most challenging question with respect to motivated reasoning is how the minimal impact on climate change of some actions can be communicated to consumers without reducing their motivation for other, more impactful actions. Consumers may be reluctant to give up on easy to execute behaviors like recycling plastic that they have long believed to be effective rather than choosing more impactful options. For example, when consumers learn that recycling is not as impactful as they perceived, will they become pessimistic about their efficacy to mitigate climate change and subsequently perceive all sustainable behaviors as less impactful? Research must understand the type of messaging that can reduce consumer reliance on accessible, low impact behaviors without decreasing both consumer motivation to engage in all sustainable behaviors and beliefs about self-efficacy to impact climate change. Doing so may require very nuanced messaging, as many behaviors cannot be clearly classified as "good" or "bad" with respect to climate change in that recycling may be good or bad, depending on the material to be recycled and the recycling infrastructure and efficiency. When considering the lowest emission option, the answer in many cases will be "it depends," even though such a response is challenging to effectively communicate to consumers. Future research is needed to understand effective communications to move away from dichotomization of behaviors as either good or bad.

Spurring systemic change at the firm level Ultimately, as shown in Fig. 1, any actions consumers take to mitigate climate change by reducing emissions take place in the broader context of the socio-political-economic system in which they live. Most consumers are likely to continue to focus on easy but relatively low impact behaviors if the system continues to encourage such behaviors (rather than the more sweeping

lifestyle changes that would stem from changes to the system). Thus, changes to the broader system are ultimately the biggest drivers of the magnitude of consumers' impact on emissions. Marketing researchers and activists focused on sustainability have long told consumers that they can drive change by recycling and "voting with their wallet." While it is clear consumers currently perceive such actions to be effective to reduce emissions, critically this is not the case. If larger systemic changes are not made, current consumption levels cannot be sustained even with appropriate use and disposition. Thus, the narrative regarding climate change needs to shift from changing individual actions to systemic reform, or to move from the current i-frame to the s-frame (Chater & Loewenstein, 2023). Though we recognize it is not enough to focus on individual behaviors such as recycling or purchase of green products, research should examine how individual's actions, attitudes, and behavior can either support or, perhaps unintentionally, become barriers to systemic change. In doing so, researchers should seek to understand who consumers currently perceive as responsible for mitigating climate change (individuals, firms, or governments) and how these perceptions can be shifted.

We first focus on research questions related to the consumer's role in driving firm-led systemic changes that can mitigate climate change. At the firm level, analysis reveals that 20 companies are responsible for almost one third of global emissions (Taylor & Watts, 2019). Focusing on reducing these corporate emissions would have a far greater impact than any individual changes. How, then, can messaging encourage consumers to demand systemic change from these firms? Further, will individuals be more effective in demanding systemic change as customers of these companies by their (lack of) purchases or in their employee role as individuals demanding change from their employer lest they take their talent elsewhere?

Moreover, consumer activists often target a single company. While a single company implementing initiatives to reduce emissions may result in a competitive advantage and spur other companies to change, the magnitude of the needed change requires industry-wide overhauls. Researchers could help activist consumers understand how they can effectively drive industry-wide change rather than focusing on a single company. This sort of research question is particularly challenging to address as it lies at the intersection of strategy, consumer behavior, and the environmental sciences, but is critical to understanding on what actions individual consumer activists should be encouraged to focus.

In addition to better understanding how consumers can drive firm-led systemic change, future research can also explore how and whether companies can serve as models for needed change without regulation. If companies use solar energy and provide charging stations for electric cars at their business and subsequently provide incentives to employees for installing solar or purchasing an electric vehicle, individuals' behaviors may shift based on these company initiatives. Similarly, if companies engage in choice editing at their employee cafeterias, switching to all vegetarian entrees, thier employees may be more open to removing red meat from at least some of their meals at home. Thus, research should examine not only how consumer activism can drive company change but also how company investments in emission reduction behaviors can spill over to impact individual behaviors.

Systemic change through public policy Research repeatedly demonstrates that beyond a certain consumption and affluence level, increases in either have only marginal impacts on people's well-being. Thus, consumers in rich countries can consume less without being worse off (O'Neill et al., 2018). Consistent with this research, a key question is how to shift consumers to focus on optimizing well-being instead of material wealth (Creutzig et al., 2022), a shift that would reduce unnecessary consumption, and what role policy/regulations have in this shift. For example, average house size has nearly doubled in less than 50 years, while the average household size has been significantly reduced (e.g., In 1950, the average US resident had approximately 300 square feet of space, whereas the same resident in 2011 had nearly 1000 square feet of space; Pinsker, 2019). Yet, smaller dwellings are easier (and cheaper) to maintain and are thus less carbon intensive compared to larger ones. Marketers should examine messaging that can effectively focus consumers on the well-being benefits from such consumption shifts rather than the perceived decrease in material wealth. Regulations can be altered to spur such change (e.g., tax breaks for those downsizing their house), though it is not clear how much consumer support there is for such policies. Future research is needed to understand what factors determine consumer willingness to accept both stricter environmental regulations and more ambitious environmental policies (e.g., creating infrastructure that allows consumers to engage in less carbon intensive commuting like high-speed electric rail). While it may seem that there is too much opposition for emission reduction policies to be adopted, history reveals similar cases: While some were resistant to taxation to reduce smoking, and taxes alone did not curb smoking, smoking rates have substantially decreased as taxes have gone up (Frank, 2023). Similarly, carbon taxation and other emission reduction policies may have a larger impact than anticipated.

Of course, it is important to recognize the resistance to such policies (e.g., see Gonzalez-Arcos et al. 2021), especially in the context of the U.S., where approximately one-third of the population does not believe climate change is happening or is happening naturally (Jackson et al., 2022). Much of this variation in belief in climate change stems from differences in political ideology. With so much resistance,

it may be difficult to implement systemic changes via policies. However, climate change is a global issue, and the U.S. does not operate in isolation. Many other countries have less resistance to climate policies, as evidenced by the 27 countries who have implemented a carbon tax or emissions trading system (Sethi, 2022). As the U.S. and other countries seek to operate and maintain a competitive position in the global economy, climate policies may need to be implemented with a top-down approach rather than waiting for consumer support for a bottom-up approach. Moreover, such regulations in other countries will impact the price of lower carbon energy in the U.S., as we have already seen substantial decreases in renewable energy prices for solar and wind, which are cheaper than gas power (Adegbesan, 2022), particularly when accounting for subsidies. Given these economics, there may be support for emission-reduction policies regardless of climate change beliefs.

Finally, in addition to research focused on factors that will influence consumer acceptance of stricter environmental regulations, future research can also focus on what individuals who do believe in human-caused climate change should be encouraged to do to effectively influence climate relevant policy. A growing segment of consumers is ready to act but needs guidance on what this action should look like. We suggest that collaboration, whether among companies, governments, NGOs, universities, or consumers is key to accomplish the necessary scale of change. Thus, research is needed to understand what spurs a desire for collective action from consumers versus individual action alone. Research can consider how collective efficacy can be driven by social movements as well as by company and industry initiatives, particularly given prior work on peer effects in renewable energy adoption (Bollinger et al., 2022; Gillingham, 2020).

Limitations to the current framework

One limitation to the conceptual model we introduce in Fig. 1 is that we have focused solely on mitigation, defined as reducing emissions to avoid "significant human interference with Earth's climate" (NASA, 2022). Consumers may be overly optimistic about the ability to mitigate climate change to the point that they do not think about changes that may need to be made to adapt to an already changed climate, that is, adaptation. This tendency to optimistically focus on mitigation, ignoring the need for adaptation, may be another bias that impacts how consumers respond to the changing climate (consistent with the optimism bias, i.e., the tendency to overestimate the likelihood of positive events and underestimate the likelihood of negative events; Sharot, 2011). Such a bias is problematic in that it may prevent consumers from taking beneficial actions that would improve life in an already changed climate (e.g., taking advantage of longer growing seasons, which new technology can help farmers optimize; Grewal et al., 2024). The reality is that many consumers are already facing a changed climate with experts stating that it may already be too late to meet the goal of keeping global warming to no more than 1.5° Celsius since the pre-industrial era (Mivielle & Macnamara, 2022), an oft touted goal in the fight against climate change. Future research is needed to explore how consumers will respond to the likely eventual shift in climate change messaging from mitigation to adaptation. Shifting the message away from what might happen to what is happening now may increase the perceived importance of climate change, potentially leading to more support for systemic change. Further, by ignoring adaptation, consumers are missing out on positive steps they could take to adapt to the changing climate, which should be effectively communicated to consumers. At the same time, messaging regarding adaptation may also have a negative impact on consumers who were previously focused on mitigation efforts, reducing their sense of self-efficacy or even creating paralyzing levels of fear and climate anxiety that prevent action (Crandon et al., 2022).

Adaptation-focused messaging could also serve to reduce another bias that we did not directly address in our model but that can potentially lead consumers away from focusing on the need for systemic change: a blind faith in science and technology to solve climate change without consumers and institutional actors needing to make major changes. If the existing impacts from climate change can be made salient to consumers, they may realize that waiting for a technological solution is not sufficient to spare humans from the worst impacts of climate change. While technology will certainly play a role in climate change mitigation and adaptation, we want to acknowledge its limitations even where we have evoked it in our framework as an avenue for behavior change. For example, while we highlighted apps that nudge consumers toward lower emissions purchases, this technology emphasizes individual level change, perhaps leading to responsibilization and drawing attention away from much needed system level changes.

Conclusions

We have focused our research agenda on important questions that marketing researchers can address to speak to stakeholders like consumers, marketing managers, and public policy makers, but a final important point is that marketing research could also play a pivotal role in informing the larger scientific community. For example, theory and empirical evidence on the ways in which sustainable technologies, interventions, or policies might affect consumer behavior and consumption patterns are urgently needed to inform product level

life cycle assessment (LCA), as well as larger system-wide models in fields such as industrial ecology, ecological economics, energy economics, and sustainability science more broadly that explore potential scenarios for climate mitigation and adaptation. Since the results of such models are often sensitive to assumptions regarding consumer behavior, using empirical evidence to go beyond simplistic assumptions could greatly improve the reliability of such models. For example, reusing or buying second-hand products is generally thought to reduce environmental burdens by cannibalizing sales of new products and reducing the need for new production. Yet this assertion lacks empirical grounding, and the limited evidence that is available suggests that, in most cases, used goods are purchased in addition to, rather than instead of, new ones (Makov & Font Vivanco, 2018). Similarly, there is little evidence that recycled materials displace virgin materials at a 1:1 ratio. These knowledge gaps severely hinder environmental science researchers' ability to estimate the potential contribution of more sustainable products or services, ranging from second-hand products to alternative proteins to shared transport services. Given the importance of climate mitigation and the need for changes at every level of the system from the macro to the individual level, marketing researchers can play an instrumental role in providing needed data and insights.

Finally, we end with a call to action. Often academic marketing researchers have framed questions around pro-environmental behavior as being prosocial, for example, grouping them in special sessions at conferences with behaviors like donating time or money to a charitable organization. However, climate change mitigation is a behavior that is essential for the health and life of every being on the planet and not optional in the same way as a donation. Rather, acting to mitigate climate change should be viewed through a moral lens, where actions are framed as moral versus immoral (Lee & Winterich, 2023). When actions to reduce emissions are framed as prosocial, individuals need to be motivated to be concerned about others, society, and the planet. However, moral values are universally available and based on the norms of the culture as part of their moral system, though moral values differ by culture and individual. Perhaps most relevant in the case of climate action are differences by political ideology (Graham et al., 2009). Yet, even though these differences exist, the magnitude of differences is often exaggerated (Graham et al., 2012). The key is identifying the moral values most valued by the target segment and framing the issues, such as climate action, as pertaining to those values (Feinberg & Willer, 2019). For example, Kidwell et al. (2013) demonstrated that framing recycling as pertaining to binding moral foundations of loyalty and respect increased recycling by conservatives, whereas framing recycling as pertaining to the individualizing foundations of harm and fairness motivated recycling among liberals. Thus, rather than relying on motivating individuals to engage in climate action as prosocial behavior, we recommend climate action be framed as a moral issue since moral values are universally available and guide behavior. Once climate action is viewed as a moral issue, marketers will need to understand which moral values are most important to the targeted segment to motivate climate action most effectively.

In addition, focusing on climate action as a moral issue may help highlight issues of environmental social justice. Climate change is a threat to everyone's physical and mental health, but socially and economically disadvantaged groups are disproportionately affected and face the greatest risks from changes in our environment due to climate change (Benevolenza & DeRigne, 2019). Such disproportionate impacts could be framed as violating moral values of duty or values of fairness, which should spur action to a greater extent than treating such individuals as recipients of charity. Given the universal presence of moral values, we would like to see the practice of researchers referring to climate change mitigation as prosocial end, as mitigating climate change is not prosocial as it is typically defined (i.e., behaviors intended to help others). Rather, it is about all our survival.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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