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ENHANCING THE USABILITY OF CLIMATE SCIENCE AND KNOWLEDGE FOR ACTION (E GILMORE AND K SCHMITT, SECTION EDITORS)

The Promise of Private-Sphere Pro-environmental Behavior as Climate Action

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Abstract

Purposeof Review This piece situates research on pro-environmental behavior within broader discussions about climate policy and action. I discuss factors associated with the adoption of pro-environmental behavior, as well as methodological limitations that should be addressed in future work.

Recent Findings Individual behavior drives a large proportion of total emissions, and lifestyle characteristics account for significant variability in individual carbon footprints. Yet behavior is difficult to change, and critics warn that "individualizing" climate action may be counterproductive. On average, interventions promoting pro-environmental behavior have produced small effects, though some promising approaches have emerged. Values matter, but strategies that modify social, informational, and structural conditions result in more impact.

Summary There is much that can be gained from a better understanding of the factors that drive environmentally significant behavior. To increase relevance, researchers should carefully consider the strengths and limitations of measures and pursue behavior-specific inquiries to complement generalized approaches.

Keywords Climate change · Mitigation · Pro-environmental behavior · Behavior change · Lifestyle · Demand-side measures · Environmental footprint

Introduction

The urgency of climate change has provoked investigation into a range of approaches for reducing greenhouse gas emissions (GHG) at multiple scales, including economic instruments, decarbonization, and investments in new technology. Yet, appeals directed to the general public to participate in "climate action" via shifts in individual consumption are among the most visible strategies in today's media. Indeed, a quick google search for "How to solve the climate crisis?" turns up a disproportionate number of recommendations that have to do with individual behaviors, such as adopting a vegan diet, unplugging unused appliances, and switching to LED light bulbs. Do these actions really matter? If so, how do we encourage more adoption? And, is this the right way to think about solving the climate crisis?

I seek to contribute to this special issue on climate action with a review of recent literature on pro-environmental behavior (PEB). Recognizing that this topic is too large to cover in a short review, I focus explicitly on private-sphere individual behavior. However, it is important to note that this is only one form of PEB. Interested readers may wish to consult several recent reviews that extend beyond the private sphere, including workplace behavior, political activism, and policy support [1–7]. There is much debate over the merits of emphasizing individual action relative to other targets. In recognition of this controversy, I begin with an attempt to situate research on PEB within the wider discourse on climate policy and action. I follow this with a discussion of key findings regarding when and why individuals are most likely to adopt PEB, noting along the way several conceptual and methodological limitations of this field. In this review, I focus on a select number of non-price factors affecting behavior, but point interested readers to reviews of economic motivators [8–11] and other more comprehensive treatments of this topic [8, 12, 13, 14••, 15, 16, 17].

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Putting Pro-environmental Behavior in Context

The term *pro-environmental behavior* refers to a broad class of actions that are either empirically associated with a reduction in some form of environmental harm or are ascribed social meaning as being good for the environment.[1] Behavioral scientists have long been interested in the conditions that foster or impede the adoption of PEB alongside other behaviors that can be characterized as investments in public goods (see, e.g., work on blood and organ donation and charitable giving [20–23]). In recent decades, growing scientific concern about climate change has stimulated a new generation of research that seeks to leverage PEB as a form of climate action, specifically seeking to reduce GHG emissions through behavior change. This has stimulated questions about how to design policies and interventions to promote behavior change, investigations into how lifestyles vary across social and economic settings, and how to foster concern for environmental protection.

The literature on PEB is especially well-situated to inform demand-side approaches to GHG emissions reductions, which involve efforts to shift demand for goods and services [24–26]. Within the demand-side literature, there is substantial attention given to the development of more efficient technologies that can provide valued services with less environmental impact. The term "behavioral approaches" is often used to describe efforts to promote the adoption of those technologies, to modify how those technologies are used (e.g., time or frequency of use), or to shift the desire for certain products or services in the first place (e.g., adopting a vegetarian diet, reducing personal vehicle use). Examples of behavioral interventions may include social marketing campaigns, public education campaigns, and product labels, nudges, as well as economic instruments (e.g., taxes, subsidies).[2] In contrast, supply-side measures directly target how goods or services are produced and usually require coordinated action above the individual level. Work focused on climate change risk perceptions, policy support, and political engagement seeks to understand the conditions that may lead to bottom-up political pressure for or resistance to supply-side policies [27, 28]

Does Individual Behavior Matter?

The extent to which individual behavior change can play a meaningful role in climate change mitigation efforts has been much debated. There is no question that behavior drives a significant proportion of GHG emissions. In high-income nations, energy used directly by individuals in their homes and private vehicles accounts for nearly 40% of national emissions [29, 30], a figure that nearly doubles after including emissions generated during the production of food and other consumer products [29, 30]. Lifestyle choices contribute significant variability. Having a personal motor vehicle, meat-intensive diet, or an air conditioner are among the most important factors determining personal carbon footprints [31–37]. Higher order decisions such as the location of residence can impact multiple lifestyle patterns through, for example, access to public transportation, length of commute, and ambient climate. Yet, it is important to note that many of these decisions are heavily constrained by access, economic resources, or other factors largely outside of an individual's control.

Recognizing these trends, several scholars have assessed the opportunities for emission reductions through behavior change. For example, Van de Ven and colleagues [36] used an integrative assessment model to evaluate the potential impacts of a suite of lifestyle changes on economy-wide GHG emissions in the European Union. They considered only behaviors that would require no up-front financial investment (e.g., low meat diet, avoiding air travel to nearby destinations) and concluded that emission reductions in the range of 5 to 16% are possible, depending on the level of behavior change. Dietz and colleagues [38] similarly proposed a "behavioral wedge" of 17 low-cost behaviors (e.g., adopting fuel-efficient vehicle, shifting driving behavior) involving currently available technology. The authors estimated that, if pursued at scale, a behavioral wedge strategy could reduce GHG emissions in the USA by over 7%, assuming empirically grounded rates of adoption in response to well-designed programs and policies.

However, many have voiced skepticism about approaches that center individual decisions and behavior. Some have argued that the rate and longevity of behavior change needed to achieve emission reductions on a scale relative to accepted targets are not realistic [7, 31]. Gardner and Stern [33] and Stern [40] have criticized the selection of some behavioral targets for being too small to matter (i.e.,

[1] This definition recognizes that some behaviors widely perceived to be "pro-environmental" may have inconsistent or questionable environmental benefits. For example, some forms of recycling reduce landfill waste but are associated with higher greenhouse gas emissions [18] and food grown with genetically modified crops are associated with less environmental degradation than some alternatives [19]. Both of these behaviors are widely viewed by the public as pro-environmental. Researchers who study PEB sometimes overlook these inconsistent impacts or may be interested in the adoption of behaviors ascribed with a particular social meaning irrespective of actual impacts.

[2] In some cases, the term "behavioral" is used to explicitly exclude approaches that incorporate economic incentives. I attempt to clarify in this article when economic factors are explicitly included or not in the term behavioral.

low *technical potential*) or infeasible due to high barriers to adoption (i.e., low *behavioral plasticity*). For example, they argue that attempts to change behaviors that require high effort and ongoing maintenance have poor prospects of success. Others have raised the more fundamental concern that, even if behavior change efforts are successful, individuals are likely to expand consumption in other ways that will offset emission reductions (known as a *rebound effect*) [39, 41]. There has been some research into the extent to which resource demand reductions are offset through rebound, with results varying substantially across sectors and based on the methods employed [42, 46, 44, 45]. Evidence suggests that rebound effects at the micro-economic scale should be planned for, but tend to account for a fraction of the gains achieved through efficiency [43–45]. This conclusion is reflected in data suggesting that energy intensity per unit of gross domestic product declines over time as nations develop [46]. However, we know far less about macro-scale rebound effects, especially those that play out in globalized economic systems where, for example, reduced energy demand in the USA could indirectly lead to higher demand in other markets [44]. As such, the capacity for demand-side approaches to reduce—rather than redistribute—net emissions remains in question.[3]

Others have raised more philosophical concerns, especially regarding the "individualization" of responsibility for solving complex environmental problems such as climate change [39, 41, 47–50]. Such arguments have noted that efforts to pursue individual-scale behavior change tend to emphasize the adoption of "green" consumer products (e.g., LED vs incandescent lightbulbs) or simple and painless actions that do nothing to shift larger cultural, structural, and sociopolitical forces driving dependence on fossil fuel. For example, Shove [48] argued that the prevailing paradigm within the climate change and behavior literature "does not contain within it the terms and concepts required to discuss or debate significant societal transformation (p. 1277)." Some have cautioned that behavior change programs may even risk reinforcing the status quo by shifting emphasis away from the very political and economic institutions that drive and constrain our behavior [39, 41, 47]. Such critics of behavioral approaches tend to share some level of skepticism that technological developments can achieve a decoupling of consumption and environmental harm, at least on the scale needed to mitigate the worst effects of climate change. For example, Crompton [39] argued that even if the carbon footprint of individual goods and services could be reduced, an ever increasing demand for more goods and more services within a growing population is likely to overwhelm any benefits achieved.

[3] There are substantial benefits that could be gained from shifting consumption from high-income to middle- and low-income markets in terms of reducing global inequality in standards of living. As such, depending on the scale of rebound, demand-side management may still contribute to improvements over the status quo, even if not a reduction in net GHG emissions.

Political Feasibility and Spillover Effects

An important point of departure between those advocating for and against behavioral approaches has to do with beliefs about the political feasibility of passing more systemic policy change. Few advocates of behavioral approaches (indeed, none that this author is aware of) suggest that this strategy should be pursued instead of supply-side measures, or in lieu of more structural or systemic change. Rather, proponents often point to the intense political polarization surrounding climate change, especially (but not only) within the USA; making the possibility of comprehensive climate policy unlikely [51–53]. Policies designed to reduce demand through efficiency gains tend to attract broader bipartisan support and are considered cost-effective strategies for reducing emissions [54–56]. It stands to reason that many behavioral advocates view the prospect of realizing even more radical socioeconomic transformations, as has been called for by some behavioral critics, to be even more unlikely. In response to appeals for radical reform such as economic "de-growth" [57], others have warned that a new set of problems might also emerge—including declining social capital, distrust in institutions, and increased poverty—all of which compromise the health of democracies and may undermine our ability to respond to climate change at all [58]. Nevertheless, several behavioral scholars have proposed ways to incorporate concerns raised by skeptics in an attempt to mitigate some of the risks inherent in emphasizing individual behavior [59–61].

Importantly, there is an embedded assumption throughout much of the PEB scholarship that targeting individual consumption complements, rather than competes with, other strategies. Critics of behavioral approaches often point to concerns that individualizing climate action could crowd out other more robust approaches. The term behavioral spillover refers to when an intervention to promote PEB leads to secondary effects—positive or negative—on non-targeted behaviors [62, 63]. Behavior change skeptics sometimes question whether the adoption of simple and painless PEBs could lead individuals to feel morally "off the hook" when asked to engage in more impactful but difficult behaviors [39, 41]. Even more concerning is the possibility that promoting low-impact behaviors might undermine support for "hard" policies such as taxes or regulation. Two recent meta-analyses reveal that when individuals are nudged to adopt a PEB, it results in a small increase in intentions to do more

green things—likely reflecting a pro-environmental attitude shift—but has no positive or negative impact on the adoption of subsequent PEBs [63, 64]. Relatively few studies have assessed spillover effects on policy support, making this an important gap that should be addressed in future research. Hagmann and colleagues [65] found that when participants were shown a policy alternative that involved soft approaches to achieve emissions reductions (i.e., a green energy default nudge), they were less supportive of a carbon tax. However, on balance the evidence is mixed, with others reporting null or positive effects on policy support [63, 66, 67].

Factors Related to the Adoption of Pro-environmental Behavior

Under what conditions are individuals more or less likely to adopt PEB? Recognizing that there is a large and complex literature in response to this question, I selectively discuss several factors that I consider to be most relevant in the application of PEB research to wider discussions of climate policy and action. Throughout this discussion, I also draw attention to conceptual and methodological gaps that should be considered in future work.

Sociodemographic Characteristics and Measurement Artifacts

Research within US and European samples has found that women consistently report higher rates of PEB relative to male peers [68–71]. The effect of age is less consistent, with some studies suggesting that older age groups report higher rates of PEB [68, 69, 72, 73], and others revealing negative or curvilinear relationships [74]. Associations with education and income are far more contingent on the way that PEB is measured, raising important methodological considerations. Studies that attempt to measure environmental footprints, such as total household energy consumption, have generally found positive relationships with income [75, 76•]. Alternatively, when PEB is measured as engaging in behaviors designed to *minimize* one's environmental impact [76•], the range of actions that count expands dramatically [68, 76•, 77]. Such approaches often measure whether efficient technologies have been acquired (e.g., energy-efficient washing machine, fuel-efficient vehicle) rather than whether one possesses certain technologies at all. Similarly, insulating one's home is often counted as a PEB, but total household square footage is rarely measured. Several studies using common "impact-minimizing" conceptualizations of PEB suggest that income and education are associated with more pro-environmental action [72, 74, 76•, 78].

Table 1 illustrates the significance of this measurement approach using data from the 2010 implementation of the *General Social Survey* (GSS), a representative cross-sectional survey of the American public that has been ongoing since 1972. This table summarizes relationships between several demographic variables and the adoption of five PEBs. The dependent variables indicate whether the respondent has, for environmental reasons, driven less, reduced energy use, reduced water use, or avoided purchasing certain products—questions that are characteristic of common PEB measures [79]. The fifth dependent variable represents whether the respondent has a personal motor vehicle.

These data partially replicate earlier findings in that men are approximately 20 to 30% less likely to report adopting four out of five PEBs relative to their female counterparts, and age has a small and inconsistent relationship with PEB. We can also see from Table 1 that there is a minimal role of wealth and having more education is generally associated with higher rates of PEB. The exception to these trends is the fifth dependent variable representing whether the respondent has a personal vehicle (model E)—known to be one of the most important lifestyle factors affecting carbon footprints [33, 36]. Here, we can see that those with no college education are 3–4 times more likely to exhibit this PEB, and those in the lowest wealth quartile are more than 13 times more likely than the highest income group.

There are several good reasons to include a wide range of actions in measures of environmentally significant behavior. For example, environmental footprints are sometimes methodologically more difficult to assess than items like those in the GSS [79]. In addition, certain behaviors that are strongly correlated with carbon footprints are not socially desirable end states in many settings. For example, lacking a personal vehicle in areas with limited public transportation is associated with poor employment outcomes [80]. Consequently, it is important to understand the conditions under which individuals take steps to mitigate impact within a certain level of affluence. However, scholars in this field should strive to capture indicators of environmental footprints when possible. They should also be careful when drawing conclusions about environmental impact based on data about PEB. The two are not interchangeable. Moreover, we can see from Table 1 that the predictors of "impact-minimizing" PEBs are different than those for vehicle possession, suggesting that these items are not substitutes for one another when testing theoretical models.

Do Values Matter?

The assumption that fostering environmental values will lead to the adoption of PEB is implicitly embedded within many behavioral interventions. Similarly, many scholars advocate for targeting values, rather than promoting specific actions, due to the expectation that values are global drivers of behavior across time and context [81,

Table 1 Summary of logistic regression results predicting participation in five pro-environmental behaviors using demographic characteristics (source: GSS data)

	(A) Drive less		(B) Reduce energy use		(C) Reduce water use		(D) Avoid products		(E) No personal vehicle	
	OR	*SE*	*OR*	*SE*	*OR*	*SE*	*OR*	*SE*	*OR*	*SE*
Male	0.71**	0.09	0.65**	0.09	0.81^	0.10	0.81	0.11	0.96	0.27
Age (ref: 18–24)										
26–34	0.56*	0.13	0.58*	0.15	0.75	0.17	1.31	0.32	0.63	0.34
35–44	0.61*	0.14	0.68	0.18	0.69^	0.15	1.68*	0.41	0.74	0.41
45–54	0.59*	0.14	0.70	0.18	0.84	0.19	1.37	0.32	1.43	0.65
55–64	0.94	0.23	0.88	0.24	0.84	0.19	1.40	0.34	1.55	0.75
65–74	1.14	0.29	0.86	0.25	0.89	0.22	1.21	0.31	1.42	0.70
75 +	0.50*	0.16	0.55^	0.18	0.72	0.20	0.66	0.19	4.75**	2.19
Highest degree (ref = high school or less)										
Associate/bachelors	1.26	0.20	1.76**	0.34	1.53**	0.24	1.82**	0.34	0.19*	0.14
Post-graduate	1.88**	0.40	1.61^	0.41	1.10	0.23	1.85*	0.46	0.28	0.30
Income (ref = < $20 k USD/year										
$20– < $40 k	0.79	0.14	0.81	0.15	0.78	0.13	0.83	0.15	0.31**	0.10
$40– < $75 k	0.91	0.16	1.04	0.20	0.96	0.16	1.10	0.21	0.08**	0.05
$75 k and above	0.69*	0.13	0.90	0.18	0.79	0.14	0.85	0.17	0.06**	0.04
Constant	1.93**	0.39	4.64**	1.09	1.83**	0.36	1.99**	0.40	0.16**	0.06
LR χ^2	44.10**		31.60**		17.31**		36.64**		113.15**	
Pseudo R^2	0.03		0.02		0.01		0.03		0.21	
n	1,181		1,251		1,251		1,251		1,251	

OR, odds ratio; *SE*, standard error; *p*, *p*-value (alpha). For models A–D, respondents were asked how often they peform each behavior for "environmental reasons" and response options *sometimes*, *often*, and *always* were recoded as "1" and *never* was recoded as "0." Source: Smith et al. [88]

82]. Whether these assumptions are true is a fundamental question within the study of PEB.

The term value is defined by psychologists as a relatively stable, trans-situational principle that guides an individual's evaluation of behaviors and events [83]. Psychologists often distinguish values from constructs such as attitudes, goals, identity, or personal norms. For the purpose of this discussion, I do not delineate between these constructs, but consider them all facets of the extent to which an individual values environmental protection. On balance, studies reveal small positive correlations between values and PEB [69, 84–86]. For example, Katz-Gerro and colleagues [84] demonstrated a small positive relationship between biospheric values and six forms of PEB across samples in Germany, India, Israel, and South Korea. Likewise, Evans et al. [87] demonstrated that making pro-social values salient is associated with increased adoption of a relatively simple PEB (recycling) in a laboratory setting.

However, we also know that the importance of values varies across PEBs. One common explanation is that environmental values influence PEB most strongly when the barriers to adoption are low. This theory, referred to as the "low cost hypothesis" [88], is supported by data revealing that the correspondence between environmental concern and PEB weakens as behavioral difficulty increases [88, 89]. For example, Diekmann and Preisendorfer [88] demonstrated that environmental concern is more strongly correlated with recycling among residents with access to curbside recycling. However, more recent findings dispute this conclusion, suggesting that behavioral difficulty reduces overall adoption, but does not wipe out the role of values entirely [82, 90]. Regardless, there is strong evidence that behavioral difficulty is a more powerful predictor of adoption than values. Likewise, interventions that appeal to or attempt to promote environmental values have small to negligible effects on observed behavior [14••]. Values are perhaps better understood as important to the formation of intentions or goals to minimize one's impact [75], and efforts to reduce structural barriers to behavior change can empower individuals to act more in line with how they feel.

What Interventions Work?

Moving beyond environmental values, what else impacts the adoption of PEB and do behavioral interventions work? Nisa and colleagues [14••] recently conducted a meta-analysis of randomized and controlled studies measuring observed (rather than self-reported) behavior change in response to several common non-economic behavioral interventions. Although scholars have debated how to interpret these results [40, 91, 92], their findings

reveal a very small average effect on PEB ($d = -0.09$). Likewise, there is little evidence of persistent change after interventions end. The authors also found substantial heterogeneity in effect sizes across behavioral targets, as well as type of intervention used. In line with prior findings, more difficult behaviors were less susceptible to change. Recycling, which is supported by extensive infrastructure in many parts of the world, was found to be the most "plastic" in response to interventions ($d = -0.46$), whereas water, energy, and car use were the least responsive ($d = -0.04$ to -0.09).

The most promising interventions to emerge from this meta-analysis included normative feedback and default nudges. Normative feedback seeks to change behavior through peer influence by presenting information suggesting that one's peers have adopted a PEB, or by explicitly comparing the recipient to their peers (e.g., displaying one's household's energy use relative to one's neighbors). Individual evaluations of normative feedback interventions have revealed small but significant effects [93–95]. The meta-analysis also revealed a small average effect size ($d = -0.08$) that could be easily dismissed as negligible. However, it is important to interpret treatment effects in context with the cost and scalability of an intervention. Normative interventions have proven to be highly scalable and relatively easy to administer. For example, Allcott [93] demonstrated that comparative feedback reduced household energy demand by approximately 2% but noted this effect is comparable to the behavioral response expected from an electricity price increase of 11–20%.

Default nudges [96] refer to interventions presented to consumers faced with an explicit choice to participate in a program (or not) that may affect their social or environmental impact. Shifting the default settings for these decisions can result in large-scale behavior change, while preserving free choice for those affected [97]. For example, in nations where citizens are given the option to opt out of being an organ donor, rather than opt in, the proportion of those consenting to donate is roughly 60–95% higher [98]. Liebe et al. [99•] demonstrated that shifting the default setting for consumers within two Swiss electricity markets resulted in an immediate 82 and 88% increase in enrollment in green energy packages. In both cases, over 80% of customers maintained the default (green) package for at least 4 years and demonstrated no corresponding change in energy consumption. Indeed, meta-analytic findings suggest that default nudges were the most impactful intervention assessed, with an average effect size of $d = -0.35$ [7].

Conclusions

Several additional insights emerge from this review that relate to current limitations and future directions in PEB scholarship. First, there is much attention within the PEB literature about how to motivate environmental concern or the intentional adoption of PEB. However, it is noteworthy that two of the most promising interventions to emerge from this field do not depend on shifts in values or beliefs. As discussed above, values are important to the adoption of PEB. However, there is also clear evidence that individuals can be nudged towards more sustainable behavior without necessarily changing minds. Bypassing political polarization is a significant motivation for behavioral approaches to mitigation. It is therefore important for researchers to continue exploring interventions that can reach diverse audiences with heterogenous values, and who may be unamenable to interventions that appeal to environmental concern.

Second, crafting effective climate policy requires a sophisticated understanding of the complex causes of GHG emissions. PEB research will be more relevant to these discussions if scholars can point to findings associated with behaviors that meaningfully contribute to emissions. I echo calls from others to focus on behaviors that matter most [76•, 100] and approaches to behavior change that are potentially scalable. Likewise, behavior-specific models that account for the relative importance of specific barriers or facilitators may be more relevant to policymaking than efforts to abstract from context in the pursuit of generalizable but less explanatory theories [100].

Finally, when pursued in isolation, behavioral interventions have relatively small impacts. Yet, rarely are they considered in tandem with strategies that affect the cost of or barriers to behavior change [40]. Many experts argue for using a suite of interventions that simultaneously address cognitive, informational, structural, and other barriers to PEB [59, 101]. The weight of evidence to date suggests that behavioral approaches have strong potential to complement, rather than compete with, other strategies [40, 102]. However, more research is needed to understand whether behavioral approaches might crowd out support for other forms of climate action.

Declarations

Conflict of Interest The author has no relevant financial or non-financial interests to disclose.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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