



Achieving transformational change through the consilience of behavioral science and radical alternatives

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Abstract

The integration of behavioral science into conservation science and climate science has enabled the development of both novel research questions and practical interventions. However, most behavioral interventions aim to change private, individual behaviors, rather than transform the political economic systems that drive current biodiversity, climate, and social crises. In this paper, we argue that closer collaboration between behavioral scientists working on biodiversity and climate issues, on the one hand, and advocates for radical alternatives to current political economic systems, on the other, could advance such needed systemic transformation. While the work of both groups is subject to some critique, we suggest that closer collaboration could enable the strengths of each to address the others' weaknesses. This complementarity is particularly true when behavioral interventions are co-designed with advocates and targeted towards powerful individuals whose behavior could affect systems-level transformation. We use the fossil fuel divestment movement as an illustrative example of one way in which this collaboration could be mutually beneficial, and then outline potential political, practical, and ethical implications that may accompany such collaborations in the biodiversity conservation and climate change fields.

Keywords Behavior change · Pluriverse · Transformational change · Fossil fuel divestment · Behavioral science · Sustainable transitions · Biodiversity conservation · Climate change

Introduction

Humankind has exceeded the capacity of the Earth's environmental systems, driving environmental change and increasing the likelihood of a perilous future (Richardson et al. 2023). Global environmental policy has responded to increasing threats to the environment and society by calling for transformational change (CBD 2022; IPCC 2022). For

instance, the Kunming–Montreal Protocol's Global Biodiversity Framework envisions “a world of living in harmony with nature” by 2050 (CBD 2022). This vision is underpinned by shorter-term goals that can be achieved through changes in social structures and human behavior. The complexity of meeting these goals and achieving transformational change requires a transdisciplinary perspective that is attuned to environmental justice implications of implementing such change (Wyborn et al. 2021; Deutsch et al. 2023; Obura 2023). A transdisciplinary perspective is particularly important given that contemporary social and environmental problems are rooted in political economic systems and manifested partly in human behaviors (Rosales 2008; IPBES 2019; McElwee et al. 2020). For example, atmospheric CO₂ is temporally aligned with expanding industrialization, consumption, and globalization (Steffen et al. 2015); biodiversity loss is driven by global trade (Lenzen et al. 2012; Hoang et al. 2023); and the structure of global trade networks results in ecologically unequal exchange, whereby environmental degradation in the Global South is driven by consumption patterns in the Global North (Givens et al. 2019; Dorninger et al. 2021). These consumption patterns

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are one piece of evidence showing how such political economic drivers are expressed in human behaviors (Toth and Szigeti 2016). Others include continued growth of unsustainable meat consumption (Sans and Combris 2015) and increasing production of plastics and their unmanaged disposal (Geyer et al. 2017).

Despite the positive feedback between political economics and human behavior (O'Rourke and Lollo 2015), the two are often treated separately in the environmental conservation and sustainability literature, e.g., climate, biodiversity, and water conservation (Rauschmayer et al. 2015; Kaufman et al. 2021; Naito et al. 2022). Applications of behavioral science to environmental crises have generally sought to reduce individuals' consumption of natural resources to relieve pressure on biodiversity and the climate. This work includes reducing household water and energy consumption (Andor and Fels 2018; Koop et al. 2019), the consumption or use of threatened animal and plant species (Veríssimo and Glikman 2020), and reducing farmed meat consumption (Harguess et al. 2020).

Consumption behaviors, such as those listed, are supported by and reinforce political economic systems, which some researchers and advocates argue also need to change to avert catastrophic global socio-ecological change (Scoones et al. 2020). Rather than a sustainable transition, which implies a pathway to change driven by technological innovations absorbed into existing political economic structures, these groups argue for a pathway to change through social innovation that radically transforms political economic structures (Temper et al. 2018). Some of those emphasizing the need for political economic change have sought to understand how radical alternatives could uproot current social and environmental problems (Kohler et al. 2019; Otero et al. 2020; Moranta et al. 2022). 'Radical alternatives' are diverse ideas for how humanity can coexist with the rest of nature in dignity and without being subjected to diminishment, exploitation, and misery (Kothari et al. 2019). These ideas are often rooted in the experiences and worldviews of currently marginalized people, including the poor, colonized, and Indigenous, among others, and offer visions for social transformation that uproot the political economic causes of environmental and social problems. Alternatives include degrowth (Kallis et al. 2018), ecosocialism (Löwy 2005), buen vivir, or "good living" (Alonso González and Vázquez 2015), Indigenous kin economies (Kimmerer 2013), and systems that would allow for all these alternatives to exist simultaneously (Matulis and Moyer 2017; Kothari et al. 2019). In this perspective, uprooting current political economic systems is the only way to address the root causes of social and environmental problems.

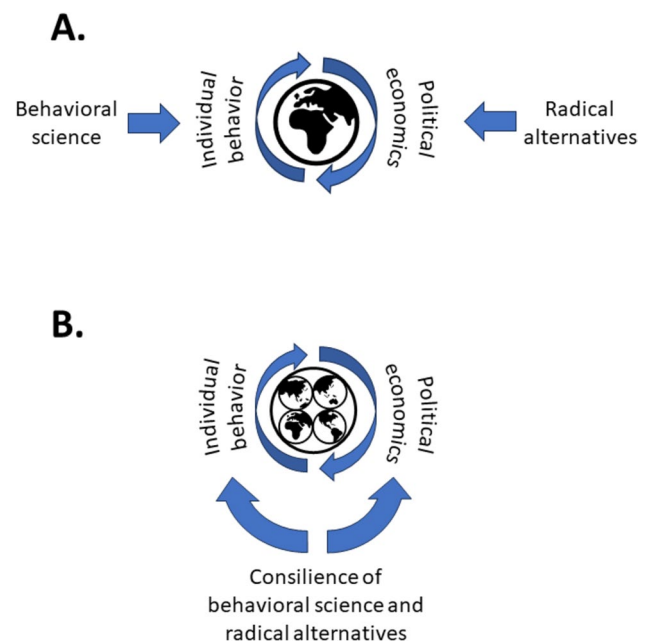


Fig. 1 **A** Behavioral science and radical alternative separately focus on individual behavior and political economics, respectively, in a world characterized by one dominant system. **B** Consilience of behavioral science and radical alternatives allows them to jointly address individual behavior and political economics, achieving transformative change and facilitating a world in which many worlds fit

This paper's aim is to argue that closer collaboration between behavioral scientists working on biodiversity and climate issues, on the one hand, and those working toward sustainable transformations, specifically advocates for radical alternatives to current political economic systems, on the other, could advance transformative change, and that doing so could help to address critiques that have been levied against both approaches (Fig. 1). Our focus on examples from biodiversity loss and climate change is due to the pressing urgency of both crises (IPBES 2019; IPCC 2022) and our disciplinary orientations, but the emanating reflections are applicable to other environmental and sustainability fields. To promote collaborations between the two fields, we first provide brief, separate overviews of (1) behavioral science applications to the biodiversity and climate crises and (2) the radical alternatives advocated by some activists and scholars. Both sections highlight the main themes of each approach and their main critiques. We then demonstrate how those critiques could partly be addressed through increased collaboration between the two camps: namely, designing behavioral interventions with advocates of radical alternatives and targeting them toward those with political and economic power. Finally, we discuss some political, practical, and ethical implications that will arise from such

collaboration, arguing that these are difficult but necessary challenges with which to engage.

Applications of behavioral science to the biodiversity and climate crises

Over the past decade, there has been an acceleration of behavioral research integrated into the fields of biodiversity conservation and climate science, including insights from economics (Gowdy et al. 2010; Gómez-Baggethun et al. 2010), psychology (Stern 2000; Saunders 2003), behavioral economics (Gowdy 2008; Byerly et al. 2018), and social marketing (Bostrom et al. 2013; Veríssimo 2013). While this body of work accounts for a relatively small proportion of published conservation and climate research in comparison to climatological, ecological and biological scientific outputs (Selinske et al. 2018; Nielsen et al. 2021b), this field carries salience for scientists, practitioners, and policymakers, as many see biodiversity loss and climate change as fundamentally driven by human behavior (Schultz 2011). In a deliberate effort to bolster the effectiveness of conservation and climate interventions, research has increasingly focused on behaviors rather than attitudes (Nilsson et al. 2020), promoted the use of robust evaluation techniques (Baylis et al. 2016), and shifted from viewing decision-makers as economically rational to those that are influenced by multiple biases and uncertainty (Toomey 2023).

The growing research in behavioral science on biodiversity and climate is focused on developing a better understanding of decision-making to design more effective interventions. As a result, behavioral interventions are beginning to be trialed across socio-ecological policy contexts globally (Hallsworth 2023) and are especially impactful when they prioritize key behaviors or actors (Selinske et al. 2020a; Nielsen et al. 2021a). There are a number of advantages in applying behavioral science to the biodiversity and climate crises. First, behavioral science is focused on demonstrating causal relationships and thus prioritizes experimental design in methodology. These methodologies provide a robust way to test the potential of interventions and their generalizability across contexts. Second, behavioral insights, especially those focused on changing the decision architecture, or the presentation of choices (i.e., nudges) can be relatively straightforward to integrate into policy and practice, resulting in small, easy gains for biodiversity conservation and greenhouse gas emissions reductions. Third, behavioral methods emphasize field experiments, meaning that their results are directly actionable by conservation and climate practitioners (e.g., Weigel et al. 2021).

Despite its strengths, behavioral science is facing a reproducibility crisis, with substantial criticism of behavioral science from outside and inside the field (e.g., Shove 2010; IJzerman et al. 2020; Hallsworth 2023). One major challenge is that behavioral interventions have small, inconsistent, and sometimes short-lived effects (Abrahamse et al. 2005; Ferraro and Shukla 2023), resulting in contextually dependent outcomes potentially without long lasting conservation or climate benefits. The uncertainty of the effectiveness of behavioral interventions also reflects the influence of social context, in that the same interventions can have effects of varying magnitude and direction when implemented in different places at different times. Relatedly, most behavioral science theories and concepts have been tested on non-representative samples drawn from WEIRD (Western, educated, industrialized, rich, and democratic) populations, challenging their validity and replication in non-Western contexts (Heinrich et al. 2010).

Additional criticism of the application of behavioral science to biodiversity and climate issues is that they tend to reinforce, rather than challenge existing political economic structures (Shove 2010). This critique is reflected partly in the fact that behavioral interventions tend not to account for the structural barriers and moderators that influence individual behaviors (Kollmuss and Agyeman 2002). But it is perhaps clearer in the lack of engagement with issues of power and equity. Crosman et al. (2022) note that such omission can lead behavioral scientists to address the wrong problem, select the wrong solution, and attend to the wrong outcomes. Ultimately, such omissions have sidelined questions of who gets to decide what behaviors are pro-environmental for whom, resulting in behavioral scientists often assuming that increasing enrollment in externally led programs is pro-environmental (e.g., Czap et al. 2019). Such assumptions have important implications concerning the extent to which they have a depoliticizing effect that undermines individual autonomy by systematically discouraging people from actively engaging in and reflecting on their own choices (Schubert 2017). Such effects tend to reinforce the existing political economic structures, rather than question them. While these ethical questions have been raised by theorists, they have yet to be seriously engaged by conservation and climate practitioners.

Social movements for radical transformation

The emerging literature on radical transformations is diverse, but unified by a critique of the current dominant political economic system, namely modern capitalism (Conway and Singh 2011). This critique generally argues that modern capitalism, in being premised on continual

growth and accumulation, is inherently unsustainable and unjust. It is unsustainable because continual growth is impossible given Earth's ecological limits (Moranta et al. 2022). It is unjust because, in an ecologically limited world, continual accumulation can only occur for some at the expense of others (Burkett 1999; Dorninger et al. 2021). Additionally, many advocates of radical transformations recognize a fundamental link between modern capitalism and other forms of oppression, including heteropatriarchy (the socio-political dominance of cis-gendered males) and white supremacy, among others, and the ideological systems that reinforce such oppression (Escobar 2020).

Social movements for radical transformations often take the form of issue-driven campaigns. For example, the environmental justice movement, which emerged from the civil rights movement in the USA, argues for addressing the systemic drivers that lead to poor and marginalized people being disproportionately exposed to pollution and other environmental harms (Mohai et al. 2009; Martinez-Alier et al. 2016). The climate justice movement arose from similar grassroots movements advocating for environmental justice within efforts to combat climate change (Schlosberg and Collins 2014). Movements for climate justice emphasize how the impacts of climate change are unevenly experienced across a range of scales, sites, and identities (Sultana 2022), largely as a result of the political economic systems that first brought about climate change (Simpson and Pizarro Choy 2023) and call for explicit consideration of justice and equity in climate change policy (Robinson and Shine 2018). The fossil fuel divestment movement, discussed below, aims to financially isolate the fossil fuel industry, and remove its social license to operate, thus leading to its collapse as a pillar of current unsustainable political economic structures (Braungardt et al. 2019). Many other issue-driven campaigns pushing for radical transformations exist, and this list is meant to be illustrative, not representative.

Apart from issue-driven campaigns, some activists and researchers argue that, to resolve socio-ecological crises, radical transformations should usher in radical alternatives, some of which we briefly summarize here (see Kothari et al. 2019 for an extensive discussion). Degrowth, a paradigm developed in Western European ecological economics, argues for reducing the energy and resource flows within society, noting that above certain levels of GDP, equality, rather than income, becomes the main determinant of well-being (Kallis et al. 2018). Ecosocialism, which arose from the convergence of ecology and Marxism, argues for organizing production as a function of social need and environmental protection, rather than accumulation, with the aim of creating an ecologically rational society founded on social equality and the democratic, collective ownership of the means of production (Löwy 2005; Saito 2017). Ecological swaraj, or radical ecological democracy, builds

on South Asian grassroots activism and the concept of self-rule to promote ecological sustainability, social well-being, direct political-economic democracy, and cultural plurality by centering governance in the collective and community, rather than the state and corporation (Kothari 2014). *Buen vivir* (good living), which is sometimes synonymous with and sometimes distinguished from *sumak kawsay* (Cuestas-Caza 2018), grew out of Indigenous Andean peoples' struggles for education in the Kichwa language during the 1930s and 1940s, and took on renewed meaning in the 1990s through Indigenous social movements and anti-development movements against neoliberalization (Beling et al. 2018). It consists of guiding principles based on communitarianism and the quality of reciprocal and supportive relationships between humans and nonhumans (Lang 2022).

Moreover, many of these radical alternatives have come together under the banner of building a pluriverse (Escobar 2018; Kothari et al. 2019). A pluriverse is an idea developed within the Zapatista movement for autonomy in southern Mexico that is meant to envision a world in which many worlds coexist. Under this banner, advocates for radical alternatives support each other's struggles against modern capitalism, while respecting their unique visions for the future. While these radical alternatives are surely distinct, they share the assumption that what is needed is not a smooth transition that addresses the symptoms of modern capitalism, but a radical transformation of the political economic structures that cause those symptoms (Temper et al. 2018).

Studies of radical transformations are not without their shortcomings, many of which their proponents acknowledge. First, while the concepts behind many radical transformations are rooted in diverse sources, and particularly Indigenous peoples, workers, and the Global South (Escobar 2020), conceptual work has substantially outpaced ethnographic and empirical investigation (Oslender 2019). This is particularly true of degrowth (Akbulut et al. 2019),¹ while many other advocates of radical transformations look to a few key exemplars, some of which they share, such as movements by Gandhians, Zapatistas, and La Via Campesina. The lack of empirical investigation limits the certainty with which proponents of radical transformations can argue that their proposals would resolve contemporary socio-ecological problems.

Second, and related, little attention has been given to understanding how such transformations can occur in ways that overturn modern capitalism (Albert 2023). Many

¹ Some work on degrowth suggests that any radical alternative not oriented around growth is an example of degrowth (Kallis et al. 2018). However, such a perspective has been critiqued from a pluriverse perspective, in that such a claim does not allow other radical alternatives to exist on their own terms (Nirmal and Rocheleau 2019).

proponents look to the strategies of environmental justice movements as ways to bring about alternatives (Temper et al. 2018; Akbulut et al. 2019; Escobar 2020), while others suggest strategic engagement with state actors, or even to ignore the state and build alternatives independently (Conway and Singh 2011). Degrowth has been critiqued as proposing a naive voluntary path to transformation (Nirmal and Rocheleau 2019). Research on understanding the strategies for transformation are particularly needed, especially given that many alternatives arose in relation to capitalism, which has a historical propensity to appropriate alternatives as a way of reproducing accumulation (Alonso González and Vázquez 2015; UI-Haq et al. 2022).

Addressing critique through collaboration

Forging collaborations between behavioral science and radical transformations could potentially allow the strengths of each approach to help address their limitations. Above, we identified two limitations of behavioral science applied to the biodiversity and climate crises: (1) that interventions tend to have small, inconsistent, and short-lived effect sizes, which limits their effectiveness at promoting pro-environmental behaviors at the necessary spatial and temporal scales, and (2) that what counts as ‘pro-environmental behaviors’ is often decided a priori without input from individuals whose behavior practitioners aim to change, thus reinforcing the status quo. These two critiques are related by the practical reality that behavioral interventions are often designed to change private actions in ways that promote better compliance or adherence with existing environmental policies and programs (Byerly et al. 2018). By emphasizing compliance or adherence, what counts as ‘pro-environmental behavior’ becomes defined by pre-existing policy goals. By emphasizing private actions, such as water consumption or buying trafficked wildlife products, interventions have limited ability to affect longer-lasting structural transformations driving how humans interact with the rest of nature (Naito et al. 2022).

Collaborating with advocates of radical transformations could help to address these critiques. First, because radical transformations by definition encompass visions for the future, what counts as pro-environmental behaviors can be built from those visions. Doing so somewhat resembles similar calls for co-designing behavior change interventions (Bowie et al. 2020). However, it differs from these calls because the target audience for the intervention may not be advocates’ constituencies. Rather the intervention audiences may be those whose behavior is hindering the emergence of the radical transformations for which advocates are struggling. For instance, many Indigenous Peoples and local communities have long histories of

struggling for environmental justice and resisting resource extraction in their territories, both through local resistance and through engagement with multi-scalar environmental governance processes (Brondízio et al. 2021). These efforts are often aimed at influencing government and corporate actors to change policies so that Indigenous and/or local worlds can thrive. In a similar way, designing behavioral interventions with advocates of radical transformations may mean that target audiences are not members of the advocates’ constituency, but policy actors who can influence governance processes and outcomes at multiple scales.

By influencing policy actors, behavioral interventions promoting radical transformations have the potential to produce larger and longer-lasting effects precisely because the individual behaviors of those actors influence structural transformation (Amel et al. 2017). Some research outside of biodiversity conservation and climate change suggests that policy actors use similar heuristics as non-policy actors to make decisions (Grose 2014; Costa 2017). In an example from climate policy, Bosetti et al. (2017) found that, at COP21 in Paris, climate negotiators’ beliefs about the severity of climate change were more strongly influenced by their prior beliefs than by up-to-date forecasts. However, other experiments have found that the unique structural position of some policy actors, such as elected officials, means that they are particularly influenced by interventions that highlight risks to their re-election (Butler and Nickerson 2011; Nyhan and Reifler 2015; Howlett and Kemmerling 2017) or new information on their constituencies’ opinions (Sevenans 2021). For instance, regardless of political party affiliation, the voting behavior of elected officials are more likely to align with constituent opinion when they are provided such information beforehand (Butler and Nickerson 2011), and they are less likely to pursue reform when given high performance ratings (Nielsen and Baekgaard 2015). Advocates of radical transformations often promote policy changes through protest, lobbying, and mass media campaigns (e.g., Hope 2021); building on these behavioral findings could increase the effectiveness of their advocacy. For example, the Environmental Justice for All Act (S.919/H.R.1705), which was written in partnership with leaders from the environmental justice movement, was introduced into both chambers of the US Congress in 2023. Given the tightly contested composition of both chambers, it is possible that during a window of political opportunity, behavioral interventions would only need to change the voting behavior of a few key legislators to allow the bill to become law. Building behavioral interventions that bolster radical transformations policies among policy actors could produce larger, longer-term structural transformation even by changing the behavior of only a few key individuals.

We also identified two limitations facing radical transformations that could be addressed through further

collaboration with behavioral science: (1) a lack of empirical evidence suggesting that proposed alternatives could resolve contemporary socio-ecological problems and (2) little attention to the strategies and processes through which transformations could come to replace capitalism. This second critique could be partly addressed through collaboration with behavioral scientists given their expertise in precisely measuring the effects of different interventions (Read and Wainger 2023; Thomas-Walters et al. 2023). This expertise is independent of whether the intervention was based on behavioral theory and of who constitutes the target audience. Because of this, designing and planning activities to promote radical transformations with behavioral scientists could help advocates of radical transformations to decide what strategies to adopt and assess their effectiveness at promoting behavior change among policy actors. As aforementioned, there is a growing body of empirical literature on the decision-making of political elites. Designing interventions around this literature, such as interventions that correct elected officials' bias about constituent opinion (Broockman and Skovron 2018) or break existing echo chambers (Jasny et al. 2015), could be potentially effective ways of advancing radical alternatives. In turn, influencing these policy actors may help behavioral scientists to realize larger and longer-lasting effect sizes, making such collaborations mutually beneficial.

Should such policies be implemented, behavioral scientists are then well equipped to examine their cascading effects on individuals' private behaviors, which could help address the other critique of radical transformations that there is little empirical evidence supporting the claim that they will address socio-ecological problems. Behavioral scientists and economists have well-established histories of testing the effects of different policy changes, particularly in the environmental realm. Such investigations have found evidence that, in some cases, deforestation can be reduced by anti-poverty policy (Ferraro and Simorangkir 2020) or by banning commercial use in community forest management (Rasolofoson et al. 2015), and that fish biomass can increase when marine protected areas are equitably governed, and authority is devolved to local communities (Fidler et al. 2022). The evaluation methods used to derive these results could also be applied under circumstances when policies promoting radical transformations have been implemented. Doing so would help to build evidence on the extent to which, and under what circumstances, radical transformations help to resolve socio-ecological problems.

In sum, further collaboration between advocates of radical transformations and behavioral scientists could

prove complementary in advancing the agendas of each and promoting structural transformation. Next, we use the fossil fuel divestment movement as an illustrative example to demonstrate how collaboration between behavioral scientists and advocates of radical transformations could be mutually beneficial.

Illustrative example: the fossil fuel divestment movement

The fossil fuel divestment movement (FFDM) serves as an ideal case to demonstrate the usefulness of collaboration between advocates for radical transformations and behavioral scientists. The FFDM seeks to reduce fossil fuel emissions by urging investors to sell stock, bonds, and other financial investments in extractive industries, thus financially isolating and collapsing those industries (Braungardt et al. 2019). The movement draws inspiration from anti-apartheid divestment strategies developed in the 1960s and implemented in the 1980s. The FFDM gained traction in 2011, when US student activists began campaigning for their universities to divest their endowments from coal (Bergman 2018). To date, approximately 1591 institutions have divested nearly USD 40.5 trillion from the fossil fuel industry (Stand.earth 2023). Strategies pursued by the FFDM include, among others, protests, marches, civil disobedience, traditional and social media campaigns, and lobbying. Doing so, they hope to shift social norms in a way that removes the "social license" of fossil fuel companies to emit greenhouse gases and recognizes divestment as a moral act of intergenerational and distributive justice (Healy and Barry 2017).

As a radical transformation, the FFDM most closely aligns with degrowth and environmental/energy justice (Kothari et al. 2019; Burke 2022). In contrast to technological efforts to limit emissions from fossil fuel production and managerial efforts to reduce household energy consumption, the FFDM is explicitly political in its aim to confront "the underlying political economy and legitimacy of fossil fuels and that system's dependence on financial markets and finance capital" (Healy and Barry 2017, p. 454). Accordingly, the main goals of its strategies are to change the behavior of political elites in both public and private institutions, who have the power to make divestment decisions (Dizon et al. 2022). While the FFDM may not advocate a complete movement beyond modern capitalism, it still aims to address one of the root causes of the contemporary social and environmental crises: the profitability of, and dependence of the global economy on, fossil fuel extraction.

It is in evaluating the effectiveness of the FFDM strategies to address this root cause that further collaboration with behavioral scientists could prove advantageous. There is ample evidence that divesting from fossil fuels does not increase the financial risk of the organizations that do so (Trinks et al. 2018; Bassen et al. 2021; Plantinga and Scholtens 2021). However, there is mixed evidence on whether divestments inflict significant economic harm on fossil fuel companies (Dordi and Weber 2019; Hansen and Pollin 2022; Zori et al. 2022). This disagreement could suggest that not enough organizations have divested from fossil fuels to have a significant impact, meaning that designing behavioral interventions based on research about organizational leaders' divestment decisions could be particularly helpful. Exploratory behavioral work has characterized leaders who have divested their portfolios of fossil fuels as positive deviants, in that they may experience higher levels of satisfaction and engagement with their organizational roles because they engaged in non-normative behavior (Walton 2018). This work suggests that the FFDM could benefit from behavioral interventions used in other sectors designed around positive deviance, such as organizing social learning networks wherein positive deviants could share their divestment experiences with their peers (Marsh et al. 2004; Foster et al. 2022). Such an intervention could help to spread divestment behaviors among organizational leaders, which, in turn, could produce potentially larger effects on the fossil fuel industry.

Behavioral science could also help to evaluate how well the FFDM movement is shifting public beliefs and social norms against the fossil fuel industry. Recent experimental evidence from three countries suggests that information about the movement alone does not significantly shift respondents' beliefs about divestment (Schwartz et al. 2023). Protests, one of the main tactics used by the FFDM to shift public beliefs, can also have varying effects depending on certain features. One laboratory experiment suggested the protests can better elicit support for their causes when the participants are more diverse, less disruptive, and act in unison (Wouters 2019). A similar experiment suggested that these same features, and particularly the size of the protest and the participants' unity, can also affect elected officials' beliefs (Wouters and Walgrave 2017). These results could be used by FFDM organizers when planning and recruiting participants for protests to increase the effectiveness with which those protests shift public beliefs about the fossil fuel industry.

These are just a few examples of how behavioral science could contribute to the FFDM. Doing so could help the movement become more effective in isolating the

fossil fuel industry, possibly reducing carbon emissions long term. Such collaboration could also help behavioral scientists to realize greater, more long-lasting effects of their interventions by directing them at political elites whose behavior could have cascading effects on socio-ecological systems. In this way, both behavioral science and advocates of radical transformations could complement each other's work to build a new future where humanity and the rest of nature thrive together.

Implications for a consilience of behavioral science and radical transformations

Our proposed collaboration between advocates of radical transformations and behavioral scientists implies several challenges and possible trade-offs to the current way these two groups tend to operate. These trade-offs occur across different epistemologies, ethical norms, and strategies and tactics. While we do not attempt to resolve these trade-offs here, we briefly discuss each here to encourage further debate and experimentation with such collaborations. We also acknowledge that these conceptual barriers are situated within academic organizations that are resistant to change and may not facilitate or reward interdisciplinary collaborations (e.g., funding and publishing interdisciplinary research, promotion structures and academic silos within universities, and lack of interdisciplinary training during and after graduate school). These structural barriers are well documented and germane to interdisciplinary collaborations across topic areas in sustainability and environmental sciences (see Pooley et al. 2014; Wallace and Clark 2017; Kelly et al. 2019).

Behavioral science is firmly rooted in Western scientific epistemology, which has mutually constituted capitalism since the seventeenth century (Rieppel et al. 2018). Yet, many visions for radical transformation and radical alternatives are based in other worldviews with different epistemologies. Therefore, building collaborations between the two will require navigating political questions of how to integrate these knowledges under different circumstances, and how collaborators will know whether their efforts are moving them towards their goals (Brosius 2010). Many efforts to decolonize or Indigenize science have suggested that these questions are not insurmountable (Smith 2012; Kimmerer 2013; Hessami et al. 2021). But given Western science's history of appropriating other knowledge systems (e.g., Grove 1996), careful and ongoing attention to these issues will be necessary for bringing other worlds into being. Nevertheless, despite epistemological tensions, we argue that behavioral science is an appropriate tool to do so specifically

because those in power, whose behavior could facilitate such transformations, exemplify many of the biases and heuristics identified by behavioral scientists (Costa 2017).

Successful collaboration between the two fields will require identifying common goals, articulating desired outcomes, and developing an understanding of language and tactics/interventions (Pooley et al. 2014). While certain aspects of radical alternatives may be against the norms of the behavioral science discipline and vice versa, there will likely be overlap and result in fruitful, impactful collaborations. It appears that the behavioral science discipline is ready for such collaboration (Schulte et al. 2020). Increasingly, research from conservation and environmental psychology are focused on targeting powerful actors and key system leverage points or generating collective action (Selinske et al. 2020b; Prentice and Paluck 2020; Nielsen et al. 2021c; Mackay et al. 2021). For instance, a shared agenda could consist of employing social norms and social influence approaches to promote collective action, employing persuasive communication techniques to engage and mobilize individuals, or even investigating, testing, and evaluating what types of disruptive and nonviolent protest will be tolerated or supported by key segments of the public.

The collaborations we propose here also imply a closer union between science and advocacy. Their relationship has always been a part of conservation biology as a mission-driven discipline (Soulé 1985). But recent debates have questioned how close the two can become before science loses its integrity and credibility (Peery et al. 2019). Garrard et al. (2016) argue that scientists should practice responsible advocacy, whereby they transparently disclose their values upfront and mirror medical science's explicit emphasis on producing evidence for effective advocacy. We echo this argument, and note that, as suggested by our example of the FFDM, collaborations between science and advocacy can be mutually beneficial for both understanding and enacting transformative change (Sovacool 2022). For instance, further collaboration between behavioral scientists and the FFDM could provide scientific insights about behavioral spillovers and systems transformation (Nash et al. 2017), while also increasing the effectiveness with which the FFDM works to isolate fossil fuel companies. It is also important to recognize that much of behavioral science has been value-laden and applied in a way that, sometimes implicitly and sometimes explicitly, advocates for certain positions. For instance, behavioral experiments that assess the effectiveness of interventions to promote farmers' enrollment in government-run climate-smart and sustainable agricultural programs (Wallander et al. 2017; Czap et al. 2019) aim to increase the effectiveness of enrollment interventions, thus assuming that enrollment is beneficial to farmers and the environment. Our argument only seeks to ask how behavioral science might

change if it seeks to build evidence for radical alternatives, rather than existing political economic structures.

Despite the challenges, we suggest some ways to initiate collaborations between behavioral science and radical transformations. As a starting point, engaging across such disparate research areas requires openness, humility, a willingness to engage and creativity (Pooley et al. 2014; Moirano et al. 2020). Creativity is especially important, as an unconventional collaboration necessitates unconventional thinking to bridge knowledges and generate innovation. An initial step towards building a relationship could be to host joint discussion panels examining and debating the benefits of collaboration at conferences such as an interdisciplinary environmental conference (e.g., International Association for Society and Nature Resources), an interdisciplinary psychology conference (e.g., American Psychological Association), and/or a geography conference (e.g., International Geographical Union). Additionally, identifying relevant boundary objects may facilitate shared understanding between the two disciplines. For instance, Iwińska et al. (2021) posit that energy justice is conceptually robust across multiple disciplines and practices and as a boundary object can aid in building "cooperation among scholars, policymakers, activists, and grassroots movements" (Iwińska et al. 2021, Pg 1). Admittedly, few, if any, examples of collaborations between behavioral science and radical transformations exist, but a potential suitable multidisciplinary model of cooperation to draw from is the ACKnow-EJ (Activist-academic-co-production of knowledge for Environmental Justice) project (see Temper et al. 2018). This project is formed by scholar and activists across multiple contexts that seek to support social change and local resistance to extractive mining, while understanding processes of transformation and the effectiveness of resistance (Temper et al. 2018).

Transformative change of society is likely the most effective way to mitigate the impact of climate change, protect and restore biodiversity, and foster a future world that is livable and equitable. Achieving such a vision, which succinctly encapsulates the vision underpinning global policies such as the Kunming–Montreal Protocol Global Biodiversity Framework, requires both individual behavior change and change in the political economic structures in which individuals and groups of individuals are embedded. Individual and structural changes are inextricably linked feeding back and reinforcing the other. Navigating the tensions between severe and abrupt state change and more incremental change will be challenging for the fields of behavioral science and radical alternatives, but working in collaboration the two fields have much to gain. Ultimately, this will likely make them more effective in their common goals which is to bring about substantive global change.

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