nature climate change

Perspective

https://doi.org/10.1038/s41558-024-01951-1

Realizing the full potential of behavioural science for climate change mitigation

Received: 5 July 2022

Accepted: 6 February 2024

Published online: 15 March 2024

Check for updates

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Behavioural science has yielded insights about the actions of individuals, particularly as consumers, that affect climate change. Behaviours in other spheres of life remain understudied. In this Perspective, we propose a collaborative research agenda that integrates behavioural science insights across multiple disciplines. To this end, we offer six recommendations for optimizing the quality and impact of research on individual climate behaviour. The recommendations are united by a shift towards more solutions-focused research that is directly useful to citizens, policymakers and other change agents. Achieving this vision will require overcoming challenges such as the limited funding for behavioural and social sciences and structural barriers within and beyond the academic system that impede collaborations across disciplines.

Behavioural science is the study of individual and household behaviour conducted within diverse disciplines such as anthropology, economics, political science, psychology, sociology and transdisciplinary research. Individuals and households can affect climate change in many spheres of life, including as citizens, consumers, organizational participants, community members and investors. For example, the consumption of goods and services accounts for a substantial proportion of GHG emissions[1]. Behavioural science research on climate change mitigation has often focused on individuals' behaviour as consumers. Existing research has primarily focused on frequently performed behaviours (for example, recycling, food choices or travel modes), the predictiveness of individual characteristics (for example, knowledge and attitudes) and individuals' responses to initiatives for change. These foci are important, and behavioural science has developed useful findings reviewed elsewhere[2–7].

However, behavioural science research can contribute much more to understanding and advancing climate change mitigation. In this Perspective, we propose a collaborative, interdisciplinary, solutions-focused research agenda to enhance the scope, quality and scientific and practical impact of research on individual behaviour in climate change mitigation. We offer six recommendations for research on individual climate behaviour (defined broadly as the behaviour of individuals that directly or indirectly affects GHG emissions) (Fig. 1). Recommendations 1–3 are about what research to prioritize. Recommendation 4 proposes how to improve research methods. Recommendations 5 and 6 focus on the interpretation, accumulation and communication of behavioural knowledge and integration of behavioural science research with other sciences and with practice. Some recommendations are complicated, effortful and dependent on resources. We therefore emphasize the critical enabling roles of universities, funders, governments and other organizations. Although the recommendations focus on climate change mitigation, they may equally apply to research on individual behaviour in relation to climate adaptation or biodiversity conservation[8]. In developing the recommendations,

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https://doi.org/10.1038/s41558-024-01951-1

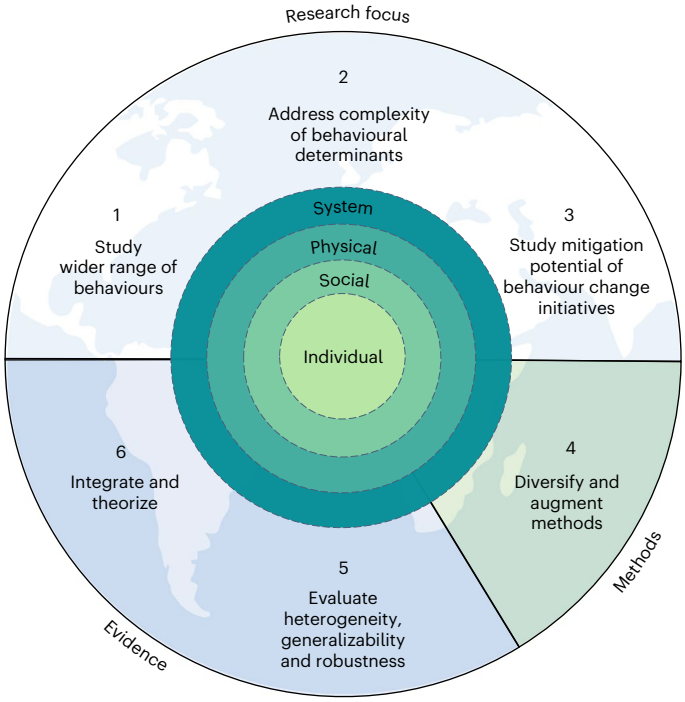

Fig. 1 | Six recommendations for behavioural science to study individual climate behaviour. Behaviours and their determinants can relate to different levels: individual, social, physical and system. Credit: world icon, Arafat Uddin, Noun Project, adapted under a Creative Commons license CC BY 3.0.

we synthesized knowledge across the behavioural sciences. Our synthesis identified key shortcomings in current practices, often resulting from disciplinary siloes and methods. While some of these shortcomings were previously known, we systematically integrate them into a coherent, new research agenda with concrete recommendations accessible to a broad audience, including behavioural researchers already working in the field and those transitioning into it. Our proposed research agenda includes theoretical and methodological recommendations to stimulate more robust and transparent research that better reflects the diverse contexts in which climate-relevant behaviours occur. Implementing these recommendations may foster greater collaboration within the behavioural sciences and with other research communities, facilitating the further integration of behavioural sciences into areas such as technological development, infrastructure planning and climate modelling.

Study a wider range of individual climate behaviours

Many behavioural scientists implicitly equate individual climate behaviour with consumer behaviour. Much behavioural research has focused even more narrowly on everyday activities[9,10]. Less research exists on acquiring and maintaining high-impact consumer durables such as homes, appliances and motor vehicles and activities such as air travel[7,11].

Although changing consumer behaviours is crucial for mitigation[12], individuals can also affect GHG emissions in other spheres of their lives[6,13]. For example, individuals can promote behavioural changes at work[14] and in their local communities[15,16], promote mitigation initiatives within organizations and institutions[13,17], shift private financial investments to low-emissions companies and mutual funds[18], vote for political candidates that support ambitious climate action[19] and participate in social movements that promote transformative political and organizational initiatives[20]. Individual landowners can deploy their land to generate renewable energy[21] or restore natural habitats[22]. Educators, journalists and other communicators can incorporate climate change into their work[23], and everyone can spread climate beliefs and norms through social interactions. Thus, individual behaviour is not limited to the consumer sphere but shapes societies on different levels; this variety of climate-relevant behaviours should be reflected in behavioural research.

Most attention has been directed towards behaviours that promote climate change mitigation. But individuals can also engage in activities that undermine mitigation efforts. These include obstructing renewable energy projects, lobbying policymakers to oppose climate policies, spreading climate change misinformation or mobilizing shareholders to continue or delay the phase-out of GHG-intensive activities. Some research exists on how specific individuals or citizen groups have opposed renewable energy projects[24,25] and how interest groups, academic institutions and individual researchers promote climate change denial or policy delay[26,27]. However, individual behaviours that delay or counteract climate change mitigation efforts remain understudied.

Address the variety, complexity and interconnectedness of behavioural determinants

Behaviour is the result of a complex interplay between individual characteristics and larger social, physical and systemic factors (Fig. 1). For example, an individual's choice of transport mode to work may be determined by personal preferences (individual), needs of other household members (social), available transport modes (physical and socioeconomic) and patterns of urban development (system). Different disciplines and theoretical perspectives speak more confidently about some determinants than others. In the following, we sketch some broad classes of determinants. Although the boundaries between determinants are porous, the distinction helps highlight their variety. Sophisticated understandings of behaviour and how to change it require drawing on and integrating insights from both fundamental and applied research emerging across disciplines. Through integration, behavioural science can more fully address who engages when and where in which individual climate behaviours, and document differences across populations and geographical, cultural and economic contexts.

Extensive research exists on individual characteristics such as psychological values, attitudes, knowledge and physical capabilities and their relevance for understanding climate-relevant behaviour[2,28]. For example, dietary and transport choices are related to environmental attitudes, self-efficacy beliefs and personal norms[29,30], and investments in climate-friendly financial products are often related to risk preferences, expected financial returns and anticipated emotions[31]. Research on individual characteristics sheds light on which individuals are more likely to engage in climate-friendly behaviour and which individual characteristics may promote or hinder action. Numerous theoretical frameworks exist that attempt to integrate and represent such individual determinants of behaviour[32–34].

Individuals also shape and are shaped by their relationships and interactions with others through social factors[35,36]. These social factors can strongly influence behaviour and make some behaviours easy and some very difficult. Consumption patterns and civic action often reflect implicit negotiations between members of different social groups. For example, different household members may have conflicting needs and desires regarding food choices, modes of transportation, material consumption or thermal comfort that affect energy use and GHG emissions[37,38]. Some research looks specifically at how peers influence one another in adopting new energy conservation practices and technologies[39]. Individuals may be motivated to make behavioural changes when observing that peers successfully did so or resist making changes if peers had bad experiences or strongly opposed the changes[40].

Behaviour is also influenced by physical and socioeconomic factors, which are mainly outside an individual's immediate control and relate to their specific living conditions and aspects of the available

choices. These factors include the individual's ownership of a residence, residential location and access to important public and commercial services. Physical and socioeconomic features and their behavioural effects systematically differ between areas and individuals, including as a function of socioeconomic status, race/ethnicity and other lines of social stratification. For example, the availability and affordability of healthy, climate-friendly food is usually lower in poorer neighbourhoods[41], and so is access to and the safety of public and active transport[42,43]. Individuals in influential political or organizational positions, such as political representatives or corporate leaders, can disproportionately influence decisions about physical environments[17].

The system-level factors that facilitate or constrain behaviour are the broad political and organizational structures that govern the operation of society. These structures include systems of government, laws and legislation, media, economic conditions and organizational codes of practice[4,44,45]. System-level factors often affect behaviour by shaping social and physical environments and therefore the capabilities and opportunities individuals have to act within them. For example, built infrastructure can lock in behaviours for decades (for example, in transport and housing[45,46]); political and cultural factors impact the type and extent of climate-relevant behaviours (for example, by shaping societal discourse and norms)[47]; legislation can encourage or discourage low-carbon private investments; and organizational goals can limit or undermine climate action (for example, promoting short-term over long-term profit).

Interconnections between determinants

Extensive research efforts have been dedicated to studying individual, social, physical and system-level determinants in isolation. However, the different types of determinant are often interconnected and can interact in their effects on behaviour. For example, subsidizing company cars on the system level may go hand in hand with changes on the infrastructural (for example, investment in car parking space) and social levels (for example, travel expectations of employers and family members), and such developments may compound to create situations in which even individuals with strong pro-climate preferences use the car. In turn, individual-level preferences may also change key factors at the system level when actual or perceived public preferences manifest in political action. Ultimately, social, physical and system-level factors strongly influence the formation and development of individual-level preferences.

Ignoring important interconnections can lead to incomplete behavioural analyses and undermine the identification of the most promising entry points of intervention to promote climate-friendly behaviours, many of which combine influences at different levels. Fortunately, promising conceptual work is emerging[4,48–51]. Empirical inspiration may be taken from, for example, research on transportation[52], energy[53] and climate adaptation[54], as well as from research traditions such as socio-technical transitions[55], cultural evolution[56] and social-ecological systems[57]. We therefore encourage behavioural scientists to study interconnections among determinants and variation across communities, countries and cultures. Currently, little is known about which system-level factors are conducive to behaviour change since they are contingent on the characteristics of the individual and the specific social, physical and socioeconomic environments individuals face[58,59]. More research is also needed to understand better when changes at the individual and social levels lead to system-level changes.

Study and evaluate the mitigation potential of behaviour change initiatives

As noted, addressing climate change requires major behavioural changes, particularly for those living in the Global North. A considerable body of research has developed principles for designing initiatives to make them more effective at promoting behaviour change by individuals and larger social entities[60] and for engaging the public in environmental decision making[61]. Initiatives, interventions and policies to change behaviour (collectively referred to here as initiatives) should generally be analysed in terms of their technical potential, behavioural plasticity and feasibility[6,58]. These factors together determine the impact of initiatives on GHG emissions, as initiatives can approach their technical potential only to the extent that they reduce behavioural, social and political barriers to adoption and successful implementation. In outlining these factors, we focus on initiatives targeting individuals, but the factors equally apply to larger entities such as corporations and other organizations[6,58]. We also present a definition of behavioural plasticity that focuses only on behaviour change in response to initiatives, thereby excluding self-initiated change.

Technical potential

The technical potential of an initiative is the reduction in GHG emissions that would be achieved if all targeted individuals change their behaviour as intended. Achieved emissions reduction is thus a function of the technical potential reduction in GHG emissions from a behavioural change and the number of individuals who could make the change. Technical potential varies substantially across behaviours and contexts. For example, the technical potential of a given change in household energy and electricity consumption can differ by an order of magnitude or more, even within the same country[62], due to differences in energy composition and carbon intensity. The technical potential of shifting purchasing behaviour across and within product types varies greatly depending on where and how the products were produced and consumed[63]. These variations in technical potential across contexts are often a result of the physical and system-level constraints noted in recommendation 2. Recent studies have attempted to quantify the technical potential of non-consumer behaviours such as voting[19], participation in environmental movements[64] and investing[18].

When setting research priorities, we recommend that behavioural scientists target behaviours with high technical potential and estimate and report the technical potential in their research. Doing so will require collaborations with research communities outside behavioural science (for example, industrial ecology, environmental science and engineering, and climate science). Further, we stress the crucial importance of behavioural plasticity and initiative feasibility, which are often overlooked in mitigation research and practice[58,65].

Behavioural plasticity

Behavioural plasticity is the degree to which a behaviour can be changed by an initiative over a given time period. Extensive evidence shows that the plasticity of consumer behaviours varies greatly with the behaviour (for example, recycling versus driving behaviour) and the types of initiative used to change it[3,9,66,67]. The available research is skewed towards certain consumer behaviours, population segments, countries and initiative types[9,10,68]. Less evidence is available outside high-income countries and on the plasticity of wealthy individuals' consumer and non-consumer behaviour. For example, individuals with high socioeconomic status have disproportionately large climate footprints[69]. They are also more likely to hold influential positions within social networks, formal organizations and political institutions, allowing them in principle to advocate more effectively for or against climate-friendly behaviours and initiatives[13,17,70]. Yet, few studies have investigated behavioural plasticity for high-impact behaviours among individuals with high socioeconomic status[13].

Initiative feasibility

Initiative feasibility is the extent to which initiatives can be adopted, implemented and scaled to achieve their technical potential[58]. Feasibility is a central research topic in implementation science, political science and public administration[71–73]. While evidence about feasibility is better developed in other domains, climate-specific work is emerging[59,65,74]. For example, the adoption and implementation of carbon

taxes vary with context and are strongly affected by the structural impacts of the proposed tax, its scope of implementation (regional, national, international), earmarking of tax revenues (for example, for climate projects) and tax dividend payout mechanisms[75–77]. Adoption also depends on public acceptance and citizens' beliefs about the effectiveness and fairness of the tax and levels of concern about climate change[75]. Behavioural insights can help design initiatives to increase the support of citizens and other actors and behavioural plasticity among targeted individuals and organizations[78,79]. Behavioural science can thus be important for understanding and increasing initiative feasibility[79] and suggests a greater inclusion of behavioural scientists in discussions around which mitigation initiatives to pursue.

Feasibility deserves increased attention in research on behaviour change initiatives. Most studies investigating the effectiveness of behaviour change initiatives are silent on whether the initiatives can feasibly be implemented at scale, how scaling may affect effectiveness and what the associated opportunity costs are. This leaves many unanswered questions that political and organizational decision makers must answer when deciding which mitigation initiatives to implement. We address these challenges in recommendation 5.

Diversify and augment the methodological toolbox

Realizing recommendations 1–3 and maximizing the quality of research on individual climate behaviour requires methodological diversity and measures with high behaviour validity. Indeed, multiple methods and triangulation across methods—including qualitative and quantitative, observational and experimental—are essential for developing robust and nuanced evidence specific to particular individuals, behaviours and contexts.

Much of behavioural science relies on self-reports of past behaviour or behavioural proxies (for example, intentions, personal norms or willingness to change[80]). Studies using self-reported behaviour or behavioural proxies can provide important starting points for identifying and understanding determinants of behaviour. However, self-reports have important limitations and can be biased, inaccurate and disconnected from actual behaviour and climate impact[81–84]. For example, people's intentions in hypothetical scenarios appear to correspond only weakly to their behaviour in situations of actual climate relevance[85]. Intentional responses to self-report questions may be of scientific interest in themselves[86], but self-reports are too often assumed to represent the actual behavioural frequency or climate impact[87].

We recommend building on previous attempts to observe the traces of impactful behaviours to supplement self-reports. For example, climate-relevant behaviour has been studied using GPS data on cars[88], readings of water meters[89] and photographs of food waste[90] (see ref. 84 for review). Similarly, attendance at climate activist events can be objectively determined rather than subjectively reported[91]. Such objective approaches may be more costly than self-report research and require stronger interdisciplinary collaboration, but these investments seem necessary to understand actual impactful behaviour.

In situations where measuring actual behaviour proves infeasible, we recommend using self-report measures designed to best approximate the frequency of behavioural performance. Widely applied self-report measures of climate-relevant behaviour typically use rough frequency categories such 'sometimes' or 'often.' However, this has high measurement error and precludes calculating GHG emissions with techniques such as life-cycle assessment[82,83]. Questions about behavioural intentions or willingness to change should consider the difference between objective and perceived inability to perform a behaviour, as well as response options for individuals who already perform them and an analysis plan for exclusions[92]. Moreover, self-report measures of behavioural intentions and climate policy support have greater validity when they highlight trade-offs such as price increases or harms to biodiversity or local livelihoods. Consequential behavioural trade-off paradigms offer interesting opportunities in this respect[93,94]. Achieving greater validity in behavioural measures will require a more substantial commitment to and funding for methodological research.

Descriptive and observational methods, including qualitative approaches[95], have tremendous value for detailing behaviours and their contexts[96,97]. Unfortunately, descriptive and observational methods have become rare in quantitative behavioural science. Many researchers tend to jump directly to testing hypotheses in online and lab-based studies, often rendering descriptive and observational research difficult to publish[98,99]. This tendency comes at the detriment of generating cumulative behavioural knowledge on which experimental research should be built[100]. Indeed, the selection, design and implementation of interventions suffer without proper understanding of the behaviour, the individuals who perform it and the surrounding social and physical environments. Laboratory and field experiments remain highly valuable for investigating mechanisms of action and behavioural plasticity, but researchers should be aware of their limitations in developing causal evidence[98]. Carefully done historical case studies can provide important insights and hypotheses about what factors influence change[101].

Better and large-scale behavioural tracking will greatly facilitate knowledge development and intervention testing[102]. In particular, making causal arguments at a large scale and understanding differences across social groups and contexts requires longitudinal data collected over time spans long enough to capture important behaviour changes across key societal events in multiple countries and regions. The methods for effectively building and analysing such datasets exist; what has been lacking is committed funding that moves beyond the scale of individual or small-group projects. Major long-term social science research projects such as the US Panel Study of Income Dynamics (50 years and counting), the American National Election Studies (70 years and counting) and the International Social Survey Program provide models of how to organize such 'big science' efforts. Such efforts should ideally also be designed to allow for effective analysis of networks and their dynamics[103].

Finally, computational modelling approaches can offer important insights into the dynamics of behaviour within social networks or larger societal systems[104,105]. For example, agent-based modelling allows for the analysis of the accumulated impact of individual-level decisions on larger societal systems, considering social dynamics such as peer effects[105]. These models further permit jointly examining the influence of individual- and system-level factors such as infrastructure constraints and policy conditions[106]. Besides providing evidence for policymakers, including aggregated adoption rates and system-level GHG emissions, interdisciplinary modelling encourages behavioural scientists to embed individual decision making within larger social, physical and systemic contexts.

Increase attention to heterogeneity, generalizability and robustness in interpreting research findings

Behavioural science has overwhelmingly studied populations in North America and Europe[3,107], and university curricula reflect this lack of global breadth[108]. Even within Western countries, sample designs and sample sizes are seldom large and diverse enough to explore the intersections of factors such as gender identity, race/ethnicity, disability status, political contexts and social class that influence socioeconomic status and create structural constraints on individual climate behaviour. For example, in the often-cited meta-analysis on behaviour change interventions by ref. 9, most of the included studies had fewer than 100 participants. The dominance of Western-focused and non-intersectional research perpetuates the assumption that behavioural and intervention research findings generalize across population groups and contexts[107,109,110]. The immense heterogeneity

in intervention effects across individuals, behaviours and contexts renders this assumption invalid. Such heterogeneity sometimes goes unnoticed when researchers communicate only non-contextualized main effects, ignore or cannot test for interaction effects and still generalize across sub-groups and contexts. For example, even within a particular context, different individuals can be affected by different aspects of the context[111]. We thus agree with calls for a 'heterogeneity revolution' in behavioural science[112], for better considering and integrating contextual and structural factors in intervention design and for broadening and diversifying studied populations[110] (even though Western populations bear disproportionate responsibility for GHG emissions[69]). Examining heterogeneity in intervention effects is also critical for assessing the accessibility of interventions for economically disadvantaged or marginalized individuals[15], such as access to subsidies or tax incentives, and addressing unintended distributional impacts of interventions[113,114].

The emergence of behavioural research conducted by large international teams[115] can partially remedy these issues by providing evidence of heterogeneity and generalizability across contexts. Moving in this direction will be a major challenge and require the commitment of substantial funding. Still, it allows the possibility of building a more robust and valuable behavioural science that can make recommendations for advancing climate change mitigation beyond Western countries.

The replication crisis in behavioural science has revealed the limited robustness of some high-profile research findings[116]. The replication crisis sparked considerable methodological reform, including the widespread adoption of open science practices (for example, pre-registration, data sharing and Registered Reports). Adopting and developing open science practices can increase the robustness, interpretability and credibility of behavioural science research (see ref. 117 for a manifesto). Recent advances in statistical methodology also allow for better assessments of the robustness of statistical conclusions[118]. However, open science practices may not be readily transferable to qualitative and historical research, which should not impede that valuable research[119].

Effective evaluation of the heterogeneity, generalizability and robustness of evidence necessitates having more detailed descriptions of study procedures, contexts and populations. This widely applies to behavioural science research but is particularly important for interventions. Extensive research in implementation science has documented how the myriad components involved in developing and implementing a behaviour change intervention can profoundly influence its effectiveness[71]. As a minimum, descriptions of interventions should specify who delivered (which parts of) the intervention, to whom, how often, for how long, in what format, in what context and at what cost[120]. These specifics are required for proper validation[121]. But as pointed out by ref. 122 (page 1): "the quality of descriptions of interventions in publications remains remarkably poor". We urge considerable expansion of study descriptions and excellent guidelines already exist[122–124]. More detailed descriptions will (1) facilitate our understanding of the circumstances under which an intervention will be effective, (2) improve precision in the identification and evaluation of causal mechanisms and (3) make the evidence more actionable for decision makers who can more easily identify promising and cost-effective behaviour change interventions for their particular context. To this end, funding agencies and leading scientific bodies should support curated repositories of such information.

Integrate and theorize

Most behavioural scientists employ a deductive approach to testing and applying theories to study individual climate behaviour. Research following this approach has made important contributions to understanding behaviour and how to change it. However, a strong focus on theory testing can sometimes interfere with the ambition to study the most impactful climate-relevant behaviours and their determinants[87,125] (but see ref. 126). When theory testing is the main study objective, researchers are incentivized to choose measures, behaviours and research settings conducive to finding effects[125]. Researchers rarely put theories to the strongest test possible to identify boundary conditions. As a result, infrequent and difficult-to-observe high-impact behaviours are often overlooked.

Addressing these issues could entail more phenomenon-driven research and inductive theory development[125,127]. Rather than starting from theory, researchers can begin with a systematic description and characterization of the most impactful target behaviours and the contexts in which they occur (recommendations 1–4). Researchers might observe context–behaviour relationships and then apply multiple methods (recommendation 4) to test their robustness and examine potential determinants. By repeating this process in other contexts and populations (recommendation 5) and with different behaviours, researchers may discover general principles and important interactions between individual and contextual factors. These may be combined to develop integrative theories and practical insights for increasing the effectiveness of mitigation initiatives in specific contexts. Giving priority to establishing robust and generalizable or contextualized phenomena will increase the relevance of behavioural research for climate change mitigation and support inductive theory building.

Behavioural science will benefit from centralized evidence synthesis and curation for more effectively integrating evidence into a web of knowledge. For example, meta-scientific consortia such as the Human Behavior Change Project[128] curate evidence across contexts to systematically map and integrate behaviour- and intervention-specific knowledge. We strongly encourage the development of a similar centralized and open science resource to effectively curate behaviour-focused research around climate change mitigation (or environmental problems more broadly). With better evidence curation, individual climate behaviour research can work towards cumulative theories that organize actionable behaviour change knowledge of direct relevance to interdisciplinary scholars and political and organizational decision makers. Moreover, continuously updated evidence synthesis (or 'living evidence') can equip decision makers with rigorous, up-to-date summaries of scientific knowledge and promote evidence-based decision making[129].

Vision for the future

This Perspective aims to highlight and strengthen the contribution of behavioural science to mitigating the existential threat of climate change. The window to avoid catastrophic climate change and realize the necessary societal changes is rapidly closing. Underpinning our recommendations is a proposed shift to more solutions-focused research[130] that continuously keeps an 'eye on the prize'. This means making behavioural science research directly useful for and accessible to citizens, policymakers, organizational decision makers, other scientific disciplines and other change agents. Doing this requires understanding how decisions are made and what factors and stakeholders influence them[131,132]. The proposed recommendations need not undermine efforts to advance theory development and can improve understanding of human behaviour. Embracing heterogeneity and context specificity will strengthen theorizing and research on mechanisms of change, which can improve intervention development.

The six recommendations reflect our vision for the future of research on individual climate behaviour and are summarized in Fig. 1. This vision should materialize in a robust, integrative and policy-relevant research program on the behavioural dimensions of climate change mitigation. Critical to our vision are more coordinated and effective research priorities, resource allocation, evidence curation and closer collaboration with other scientific communities and practitioners. These changes will aid the application of behavioural insights

towards complementing and increasing the impact of technological and policy initiatives, such as by advancing their adoption and diffusion[133,134]. One way to facilitate this collaboration is to establish new formal structures (for example, committees, scientific bodies) that collate and synthesize evidence from behavioural science and directly feed into larger scientific collaborations around climate change mitigation (for example, the IPCC). Research funders can also prioritize work that integrates consideration of technical potential with analyses of behavioural plasticity and initiative feasibility.

Achieving this vision requires overcoming various challenges within and outside the academic system. For example, solutions-focused and interdisciplinary research is not always valued and rewarded in disciplinary behavioural science departments[135]. Developing effective interdisciplinary teams can also be challenging, even with helpful reflections and insights from past experience[136]. Journals and funding bodies can better support exploratory, inductive, context-specific and multi-method research to complement the prevailing preference for deductive theory and experimental methods. This poses risks and barriers to some researchers. However, especially well-established researchers have the opportunity to become agents of change and work towards addressing such barriers (for example, as team leaders, editors, members of hiring committees and reviewers of funding applications).

Some recommendations imply more ambitious research projects whose feasibility depends on time, data and funding availability. For example, public institutions and private companies are often gatekeepers to accessing rich behavioural data and should therefore invite and more closely collaborate with behavioural scientists to transparently study individual climate behaviour. The behavioural and social sciences currently receive only a tiny fraction of the funding allocated to researching climate change mitigation[137], which constrains these possibilities. However, any substantial increase in funding must be justified by considering the associated opportunity costs. Importantly, an improved research programme on individual climate behaviour can have synergistic effects on broader climate change mitigation objectives, many of which are deeply dependent on human behaviour. These objectives include the diffusion of low-carbon technologies, implementing climate policies, reforming organizational strategies and cultures and transitioning to alternative economic and work paradigms[138]. Behavioural insights can similarly aid the improvement of other important research programmes around climate change mitigation, such as better capturing the use phase in life-cycle assessment[139,140] or more accurately representing human responses in integrated assessment models[58,141,142].

The time for action on climate change is now. Behavioural science has already generated relevant insights for taking the necessary actions to substantially reduce GHG emissions, some of which unfortunately have yet to be integrated into policy. However, we believe the opportunities for behavioural science to contribute to climate change mitigation are large and underdeveloped and that coordinated efforts can take fuller advantage of these opportunities and help minimize existential threats to civilization.

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Acknowledgements

K.S.N. gratefully acknowledges financial support from the Carlsberg Foundation, grant number CF22-1056. V.C. acknowledges support from the Swiss National Science Foundation Postdoc Mobility Fellowship (P500PS_202935). S.B. acknowledges support from the Swiss Federal Office of Energy (SI/502093-01). T.D. was supported in part by Michigan AgBio Research. F.L. was supported by an FWO postdoctoral fellowship (12U1221N).

Author contributions

K.S.N., V.C., J.M.B., S.B., C.B., T.D., U.J.J.H., L.H., F.L., P.C.S. and K.S.W. contributed to conceptualizing the research and writing the paper. All authors approved the final paper.

Competing interests

The authors declare no competing interests.

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Peer review information *Nature Climate Change* thanks the anonymous reviewers for their contribution to the peer review of this work.