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Have behavioral sciences delivered on their promise to influence environmental policy and conservation practice?☆

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After four decades of refining our understanding of decision-making processes, a form of consensus has developed around the crucial role that behavioral science can play in changing non-cooperative decisions and promoting pro-environmental behaviors. However, has behavioral science delivered on its promise to influence environmental policy and conservation practice? We discuss key lessons coming from studies into the dual process theory of thinking and the presence of cognitive biases, social norms and intrinsic motivations. We then discuss the empirical findings by reviewing relevant research published over the past five years, and identify emerging lessons. Recent studies focus on providing feedback, manipulating framing, using green nudges, or activating social norms on urban contexts, mainly energy and water. Interventions are needed in the context of common pool resources in the global south. We end by discussing the great potential for scaling-up programs and interventions, but there are still challenges for research and practice.

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Introduction

After four decades of refining our understanding of decision-making processes, a form of consensus has developed around the crucial role that behavioral science can play in changing non-cooperative decisions and promoting pro-environmental behaviors [1–4]. Environmental and natural resource management initiatives could leverage cognitive biases and social influences to increase motivation for program uptake and extend the likelihood of environmental long-term success [3,4]. However, has behavioral science delivered on its promise to influence environmental policy and conservation practice? We will answer this question by reviewing relevant research published over the past five years (2015–2020).

The first section of this article discusses key lessons coming from studies into the dual process theory of thinking and the presence of cognitive biases, social norms, and intrinsic motivations. We then discuss the empirical findings of programs and policies, and identify emerging trends and lessons. We end by discussing gaps in the literature, the scope of behavioral interventions, and avenues for further research.

What drives human cooperation in environmental dilemmas?

Persistent environmental problems, such as the climate crisis, or managing common pool resources like forests, irrigation systems or fisheries, are collective action dilemmas that require cooperation between individuals and communities across different spatial and temporal scales. Increasing socio-ecological interdependence has made palpable the consequences of not contributing to the solution of local and global problems. Cooperation requires a deviation from purely self-interest and a willingness to mutually engage in collaboration, actions that usually involve costs in terms of sanctioning free-riders.

The past 20 years of behavioral science have provided significant insights into the drivers of human cooperation and the key mechanisms to foster collective action. The dual process theory of thinking [5] and its applications regarding cognitive bias [6], and developments regarding social norms [7] and intrinsic motivations [8], represent significant breakthroughs for policy and academia that provide important insights into environmental dilemmas.

Dual process theory has been used to analyze whether cooperation is the result of intuitive, affective and associative decision-making, or if it is deliberative, conscious

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and reflective [5]. While there appears to be consensus around the fact that cooperation is intuitive (at least regarding response times in social dilemmas), recent studies suggest that being intuitive might mean looking at other peoples' cooperation intentions and then acting accordingly [9]. This is consistent with the behavioral economics literature on conditional cooperation, in which it has been determined that individuals with other-regarding preferences are usually willing to cooperate, as long as they think others will too [10]. If cooperation is automatic and dependent upon second-order beliefs, then it can be harnessed to increase, for example, environmental donations for climate change mitigation [11].

However, there are several cognitive impediments to human cooperation and coordination [6]. Cognitive biases are defined as systematic deviations from rationality in decision-making. Present bias, loss aversion, and status quo bias are key to comprehending human unwillingness to, for example, adopt green energy options [12], save electricity [13•], or contribute to maintaining or managing public goods or common pool resources [14]. The use of green defaults takes advantage of the status quo bias by making the more pro-environmental option the reference point. From an evolutionary psychology perspective, these types of decision-making bias were crucial to our adaptation and evolution as a species, and they continue to influence decision-making processes in modern times [15]. Therefore, solving environmental collective action problems also requires that we (de)activate ingrained cognitive biases.

Social norms are also a crucial aspect in explaining and promoting cooperative behaviors. A social norm is a rule of behavior that individuals conform to it conditional to their beliefs about what most people do (empirical expectation) and to their beliefs of what most people believe they ought to conform to (normative expectation) [16]. Descriptive social norms rely solely on empirical expectations, while injunctive social norms depend exclusively on normative expectations. Cooperation might emerge depending on an individual's behavioral expectations of others and the descriptive norms that prevail in specific contexts [7]. Relevant intervention aspects that have been identified in social norms literature include: making information on reference networks visible to promote energy savings [17,18] and using injunctive social norms to encourage water consumption reductions [19]. It is possible to provide solutions to collective action problems by activating or making visible desired social norms, or deconstructing problematic ones [1].

Human cooperation can also be explained, at least partially, by the presence of intrinsic types of motivation. Behavioral scientists have contributed an understanding of the important role of intrinsic motivations in explaining the adoption of pro-environmental behaviors [20,21]. One of the most-studied aspects of intrinsic motivations is the way that they interact with external incentives, and the potential risk of behavioral and motivational crowding-out. Bowles [8] has contributed to our understanding of the failure of the separability assumption: the relationship between material incentives and intrinsic motivations is not additive but interactive. Therefore, external incentives have the potential to reinforce (crowd-in) or undermine (crowd-out) intrinsic motivations under certain circumstances, and affect cooperative behavior. External incentives that negatively affect an individual's sense of autonomy, competence or social relatedness are expected to crowd-out intrinsic motivations [22]. While there is plenty of room for exploring the interaction between motivations, nudges and social norms [17,18], recent literature on incentives and motivations for conservation has started to provide empirical data that lean towards a crowding-in effect, rather than the crowding-out that was theoretically expected (e.g. Moros *et al.* [23]; Akers and Yasué [24]).

Recent behavioral interventions: trends and lessons

We rely on two recent systematic reviews [25,26] and on an updated review of 21 papers published in top 25% journals of the field between 2015 and 2020 that used randomized control trials (RCT) or natural experiments (NE) to identify the causal impacts of policy interventions. Only two of the papers included in our review are also considered in the systematic review by Ref. [25]. Both reviews were published in 2017 and 2018, thus they considered earlier papers plus laboratory experiments. Our review included exclusively RCT and NW published within the last five years. We focus on RCT's and NE's because we aim to assess the extent into which behavioral science has jumped out of the lab and started influencing real interventions. For our review, we categorized each article according to Münscher *et al.* [27] taxonomy that proposes three types of intervention: (i) *decision information* which includes interventions that change the way information is presented without altering the options; (ii) *decision structure* which includes interventions that modify the available options such as changing the default option but also their range and composition; (iii) and *decision assistance* which includes interventions aiming at reducing the gap between intention and decision, includes reminders of the preferred alternative in the decision and encourage deliberate commitment to beneficial actions. Table 1 organizes reviewed articles by type of intervention according to this taxonomy, environmental issue involved, behavioral component of the intervention, method, country, and key findings to rapidly identify main findings. From this exercise and lessons from previous systematic reviews [25,26] some trends emerge that we discuss below.

Table 1

Environmental interventions using randomized control trials and natural experiments

Münscher *et al.* [27] taxonomy	Environmental issue	Behavioral science component	Reference	Method	Country
Decision information	Energy	Feedback	Schleich *et al.* [28]	Randomized control trial	Austria
Decision information	Energy	Feedback	Shen *et al.* [50•]	Randomized control trial	China
Decision information	Energy	Feedback	Lee *et al.* [36]	Randomized control trial	South Korea
Decision information	Energy	Framing	Bager and Mundaca [51]	Randomized control trial	Denmark
Decision information	Energy	Framing	Ghesla *et al.* [13•]	Randomized control trial	Germany
Decision information	Energy	Framing	Chen *et al.* [29]	Randomized control trial	India
Decision information	Energy	Social norms	Bergquist and Nilsson [52]	Natural experiment	Sweden
Decision information	Energy	social norms	Sudarshan [18]	Randomized control trial	India
Decision information	Energy	Social norms	Pellerano *et al.* [17]	Randomized control trial	Ecuador
Decision information	Pro-environmental behavior	Social norms	Chakravarty and Mishra [53]	Natural experiment	India
Decision information	Water	Framing	Bhanot [54]	Randomized control trial	United States
Decision information	Water	Framing	Chabbé-Ferret *et al.* [35]	Randomized control trial	France
Decision information	Water	Framing	Katz *et al.* [55]	Randomized control trial	Israel
Decision information	Water	Social norms	Seyranian *et al.* [56]	Randomized control trial	United States
Decision information	Water	Social norms	Jaime Torres and Carlsson [30••]	Randomized control trial	Colombia
Decision information	Water	Social norms	Bhanot [19]	Randomized control trial	United States
Decision information and decision assistance	Pro-environmental behavior	Social norms	Terrier and Marfaing [33]	Natural experiment	Switzerland
Decision information and decision assistance	Water	Social norms	Jaeger and Schultz [34]	Randomized control trial	United States
Decision structure	Energy	Default	Kaiser *et al.* [32••]	Natural experiment	Germany
Decision structure	Waste sorting	Option alteration	Zhang *et al.* [57]	Natural experiment	China

This table organizes reviewed articles by type of intervention, environmental issue involved, behavioral component of the intervention, method, country, and key findings to rapidly identify main findings.

First, we found that the systematic reviews focus mainly on urban pro-environmental behaviors such as reducing meat consumption, recycling, and transport choices. Similarly, the majority of reviewed articles using RCTs or NEs focus on energy and water saving, also in urban environments, and most interventions target the way decision-relevant information, such as giving feedback, providing framing, and activating social norms, is presented.

Feedback is mainly used for reducing the intention-action gap by regularly providing information on energy consumption, and using different forms of delivery (e.g. mobile text messaging, a web portal, or written information by post). Feedback appears to be effective at prompting purchases of more energy efficient technologies or driving permanent behavioral change [28].

In terms of *framing*, the studies show the effects of different types of messages intended to reduce resource use. For example, in a study in Germany, a loss-framed pro-environmental incentive led to households reducing their monthly electricity consumption by 5% compared to a control group [13•]. In India, a study found that an environmental health framing (reduced air pollution emissions) is more effective for energy conservation than a cost-saving framing [29].

Regarding *social norms*, studies show that interventions are an effective tool to change behavior and that descriptive norms seem to be consistently effective across different domains [25,26]. In fact, studies show that behavioral interventions based on social norms could produce similar effects to classical price interventions [30••]. However, a decade after Allcott's [31] seminal paper, it is clear

in the literature that it is important to signal socially desirable behaviors. The absence of injunctive norm messages such as smiley-faces when consumption or behavior is below average may have an unintended or boomerang effect [1].

Second, green defaults that affect decision structure are reported to be an effective instrument for different environmental domains [27]. In particular, green defaults have been used to promote green or carbon-free energy sources such as wind, solar, biomass, and thermal energy. Kaiser *et al.* [32••] provided new evidence from a large-scale program in Germany, and report on 17 published papers referencing green nudges that influenced the choice of electricity source or energy saving. Overall, according to the authors, green default interventions are effective at increasing green energy choice, but effectiveness depends on the context and target group. Most of the studies reported on were small-scale or experimental interventions, mainly located in Germany and Switzerland, and the authors argue the need for larger-scale interventions and cross-country comparisons to promote this instrument (which could be less costly and more acceptable than traditional carbon taxes). The Kaiser *et al.* study identified a green default increase of almost 20% in green electricity consumption, independent of preexisting environmental attitudes in Germany, suggesting that green choices are made not just by people worried about climate change.

Third, more research is needed into interventions that target decision assistance techniques such as providing reminders, facilitating commitment or supporting public commitment. In our review, we only identified two studies that use commitments to promote pro-environmental behavior: in a hotel setting [33] and residential water saving [34].

Lastly, regardless of the intervention type (decision information, decision structure, or decision assistance), the majority of studies have been conducted in Europe and the United States. This trend is gradually changing, and a couple of recent studies have moved beyond urban citizens in the global north by including farmers in France [35] and households in the global south (Jaime Torres and Carlsson [30••] in Colombia, Sudarshan [18] in India, and Pellerano *et al.* [17] in Ecuador). Some studies report interventions that have a greater effect on wealthier households, or high users of water or energy [30••,36], and point to an income effect that is worthy of further exploration. For example, in an experiment conducted in South Korea, aimed at testing the effect of timely provision of electricity consumption information on households, researchers reported that new metering devices had a bigger saving impact of electricity consumption on high users compared to lower users [36]. Also, Jaime Torres *et al.* [30••] conducted an RCT in Colombia to investigate the direct and spillover effects of a social information campaign aimed at encouraging residential water savings. The results indicate that social information and appeals to norm-based behavior reduce water use by up to 6.8% in households targeted by the campaign. Additionally, Jaime Torres and Carlsson [30••] reported that the treatment effect is significant only for high users of water before the campaign and high-income households. These groups decrease water use by 10.3% and 10.1% respectively, which is statistically significantly different from the reduction among low users and poor households. As suggested by the authors (p.230), 'this result is particularly important because both high users and high-income households put more pressure on the resource, and it implies that non-pecuniary incentives can affect water use without hurting the poor'. In addition, the authors report some evidence of spillover effects, in which households that were not targeted with an information campaign also reduce their water consumption [30••]; this is highly relevant when scaling-up initiatives in a cost-effective manner, at least for short periods of time, for example during droughts. Finally, Chabé-Ferret *et al.* [35] suggest that professional farmers do not seem to react as much to social comparison nudges as consumers do, a finding that requires further study.

Discussion and final remarks: where is the next frontier?

Despite a great number of interventions using behavioral insights, the promises of behavioral science have only been partially accomplished [4]. There is great potential for scaling-up programs and interventions, but there are still challenges for research and practice. We propose four key messages to widen the boundaries of research and practice in environmental behavioral science.

First, norm-nudges are crucial for behavioral change when the targeted behavior is interdependent (conditional toa person's belief about what others are doing and what others think it is acceptable to do) [37••]. Norm-nudges rely on providing empirical ('what most people do') or normative ('what most people approve or disapprove of doing') information [37••]. The great majority of studies reviewed rely on making independent behaviors interdependent by providing social information from reference networks. An additional aspect that deserves further attention is the role of trendsetters, who are by definition the node of a network, and who, due to their position of power or their preferences, are willing to take the risk of deviating from established behaviors, in resolving conflicting social norms or promoting desired ones [16]. An interesting line of future research would be to link social norms and norm-nudges to theories of motivation. The way in which social norms and motivations interact to promote pro-social and pro-environmental behaviors is a key question that deserves to be answered.

Second, most interventions are oriented towards the same sectors: energy and water. Surprisingly, behavioral interventions aimed at managing common pool resources, such as forests, fisheries, artisanal mining and irrigation systems, are still in the lab domain or lab-in-the-field domain (see the Special Section edited by Janssen and Anderies [38], or the more recent discussion by Cardenas [39]). In fisheries, for example, traditional regulatory-tools-based-on-effort regulations, catch limits, and price-based interventions are still the norm, despite calls to use nudges [40]. One reason for this may be that behavioral interventions do not address structural problems, such as poverty, nor institutional factors that could affect incentives and cooperative choices. For example, illegal behavior and poaching in fisheries, deforestation drivers such as cattle ranching, illicit crops, land grabbing, or the use of mercury in small-scale mining, have high economic incentives and complex relationships with criminal groups that are not fully addressed by defaults, framing, or social norms. Another reason might be the lack of a comprehensive behavioral framework that incorporates complex human behavior in the studies of resource use and management and facilitate cross-disciplinary research [41]. This has been recently addressed by Ref. [41].

However, there are components of common pool resources that could be addressed at the community level with behavioral insights, such as using specific fishing gears and setting minimum fish size limits, prohibiting resource extraction in certain areas or without permits, adopting technology, and water use in irrigation systems. These local dilemmas could all be addressed with behavioral interventions that go beyond just promoting collective action, as has often been the case.

Other environmental domains have not been systematically targeted. Byerly *et al.* [25] suggest that future interventions should focus on contexts that could have a greater impact on environmental outcomes and drive the production of sustainable goods and services, such as meat consumption, family planning, and other sectors beyond the household level, such as public servants, farmers and organizations. As well as in policy interventions, behavioral science also has an enormous role to play in communicating environmental programs and the need for action, as has been seen in climate communication [42].

Third, advancing the behavioral science theoretical framework presents some challenges. In the field of economics, categorizing deviations from neoclassical theory is necessary, but traditional regulatory and price interventions cannot continue to assume that self-interest motives are the main driver of individual behavior. Behavioral environmental economics has not been successful in replacing classical rational theory to solve market failures. For it to be successful, better policies and incentive systems must be designed that are capable of changing behaviors and considering motives beyond self-interest [43,44].

In this line of thinking, research on the interaction between external interventions and preexisting social norms and motivations is relevant to domains beyond payments for ecosystem services, where there have been several advances in this regard.

Furthermore, all the research discussed here is built on a 'heuristics and biases' research agenda with a 'libertarian paternalism' framework that has several policy implications based on the use of nudges. This perspective has been criticized on different grounds, including ethical concerns regarding interventions that limit freedom and preferences although some research has found that disclosure of the choice architecture (to increase transparency) does not reduce intervention effectiveness [45]. Other research programs emphasize the use of simple heuristics as effective and efficient tools based on the notion of ecological rationality and not only as source of errors in judgement, and suggest avenues to complement nudge-based interventions [46]. We see this as a promising avenue for further research into environmental policy interventions.

Finally, most articles reviewed respond to specific studies or interventions, rather than to broad public policy approaches or programs. Behavioral interventions need to be scaled-up [47] in domains that go beyond urban problems. For this to happen, more collaboration is needed between academia, government, the private sector, and conservation and environmental organizations when designing and implementing interventions [25]. Conservation science and environmental organizations need to use behavioral science to pursue behavioral change [4], as has been the case in health, education, poverty and other development fields [48,49].

Behavioral science provides cost-effective tools, but to compete with more traditional interventions it needs to bridge epistemological divides. Although some NGOs and governments have embraced behavioral insights, some practitioners and policy makers are still wary of potential ethical dilemmas around claims of manipulation, and have doubts about the durability of behavioral change. Others suggest that behavioral science does not address structural problems, development patterns and embedded power structures. Although that could be the case, behavioral science has the potential to address urgent environmental problems by changing and influencing human behavior and decision making, alongside more structural interventions that require public action.

Conflict of interest statement

Nothing declared.

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