TOPIC 4:

Waste Management

Chapter 4 of 5 from:

The Science of Changing Behavior for Environmental Outcomes:

A Literature Review

STAP SCIENTIFIC AND TECHNICAL ADVISORY PANEL
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Introduction

Introduction

The environmental challenges facing us are striking. Whether it is the threat of the sixth mass extinction or global climate change, these challenges can seem fundamentally intractable. What links nearly all present environmental problems is their root cause: human behavior (Foley et al., 2005; IPCC, 2018). Yet this cause also presents a solution: to address these challenges, humans must act differently (Schultz, 2011). In other words, environmental problems are behavioral problems, and environmental solutions must also be behavioral solutions. Whenever one approaches developing an environmental program, what they are doing is developing a behavior change program (Cowling, 2014).

Behavior Change Levers for the Environment

Even when not explicitly identified, changing behaviors have long been at the core of delivering environmental programs. Historically, there have been three main levers pulled for changing behavior: shifting material incentives, promulgating rules and regulations, and providing information to actors.

Shifting material incentives involves increasing or decreasing the costs, time, or effort for doing a behavior. This lever has its roots in neoclassical economics, where an actor is assumed to respond to only the material incentives for engaging or not engaging in a specific behavior. Standard methods for shifting incentives include enforcing penalties for non-compliance with rules, providing rewards for positive behavior, or making a target behavior materially easier, such as removing time friction or promoting substitute actions.

Passing rules and regulations that promote or restrict a behavior is perhaps the most commonly used strategy for achieving environmental outcomes. Rules and material incentives often work together, but each can exist without the other. For example, a seller might offer an incentive to purchase a product without any legal requirement. Similarly, laws and rules can be passed without their enforcement shifting the material incentives. Even without enforcement, rules can shift behavior due to people having a general preference to conform to rules even without positive or negative sanctions (Funk, 2007) or where rules convey factual or social information (Sunstein, 1996).

Figure 1. Rare's Levers of Behavior Change Framework (Rare, 2020)

Providing actors with information has also been a common tactic in traditional environmental programming, including explaining what the desired behavior is, why it is important, and how to engage in it. Informational programs implicitly assume something similar to the information deficit model; the lack of change in someone's behavior is assumed to be because they do not know key information, rather than psychological or socio-contextual factors (Burgess et al., 1998).

While these levers can be successful at changing behavior, they have also been well-documented as generally insufficient for changing behavior on their own (Cinner, 2018). Environmental behavior change program designers have recently expanded their toolkit to include a more comprehensive set of levers for shifting behavior and achieving environmental outcomes. These levers are choice architecture, emotional appeals, and social influences. These three novel levers, along with the three traditional levers, represent the Behavioral Lever Framework for categorizing behavioral interventions in the environmental field (Rare, 2020).

Using choice architecture means constructing an actor's choice environment without changing the value of said actor's underlying options. This lever deviates from the more traditional levers by not assuming that actors are solely

influenced by their rational deliberation, but also how a choice is presented to them. There are many ways in which a designer might construct the choice environment. These include prominent strategies such as directing attention by increasing salient features or changing what outcome occurs by default, using timely moments to prompt action, and providing decision aids that encourage short- or long-term decision making.

Emotional appeals function differently by changing how an actor feels about a set of options. Humans like to believe that they deliberate over all of their decisions, yet emotions often drive our decisions. Emotional appeals can include messaging that makes the behavior feel consistent with the target actor's core identities and values or encourage the actor to experience a particular emotion known to result in a particular behavioral pattern.

Finally, leveraging an actor's social networks and influences is an effective behavior change strategy. Social influence strategies involve understanding how an actor relates to others in their social system, including those with power and prestige, and leveraging these dynamics to support changes in the actor's behavior. Changing behavior in this way often includes social learning, making behavior more observable, or shifting social norms by changing an actor's expectations for what others in their reference network are doing or think is right or wrong.

These novel strategies complete the six levers of the Behavior Levers framework. These levers provide a typology for categorizing the majority of existing behavior change interventions, often delivered in combination rather than isolation.[1]

The logic, ethics, and effectiveness of behavior change programming across these levers have been an intense subject of research. This work has mainly been conducted from the behavioral science perspective, which focuses on the cognitive processes affecting how individuals make decisions, and the social science perspective, which focuses on how social structures shape an actor's capacity and interest in adopting a behavior.

The Behavioral Science Perspective

While there are many different definitions of behavioral science, we focus on the systematic study of human judgment and decision making. This research has been conducted by those working in several fields but is most commonly associated with psychology and behavioral economics. This perspective tends to take the individual actor as the central unit for analysis and understanding behavior.

The roots of what is now commonly known as behavioral science can be traced to rational choice models in neoclassical economics and the inability of those models to account for the decisions people often make. These systematic deviations from rational choice models are known as biases, which result from people applying cognitive heuristics to solve real-world decision problems (Tversky & Kahneman, 1974).

Research in this field focuses on the decision processes that affect how an actor is making a particular decision. These processes are often described as falling into two broad and simplified categories. The first mode is quick and automatic and is more likely to be driven by an emotional reaction. The second mode of thinking more closely approximates rational choice models. This way of thinking is often slow and deliberate, and the decision-maker is generally conscious of this mode. These two groups of processes are often labeled as System 1 and System 2 (Stanovich & West, 2000). Research in the behavioral sciences primarily focuses on documenting the mechanisms underpinning System 1.

Researchers have documented a host of deviations from rational choice models in decision making and the cognitive processes underpinning them. The most extensive set of this work has been conducted in contexts where people face some risky decision, where an outcome could end up going better or worse than their current state.

1 For a more exhaustive list of the strategies in each of lever category, refer to Rare, 2020.

One pattern is loss aversion, where people feel a loss more strongly than a similarly sized gain. Another is risk aversion, where people prefer a sure thing over a risky proposition, even when the risky proposition is likely to return even more. A third is ambiguity aversion, where people prefer to choose options where they know the likelihood of the different outcomes, even when they are guaranteed to do worse. Many of these findings have been replicated frequently and cross-culturally (Ruggeri et al., 2020).

This research has also documented an effect called status quo bias, a general tendency for people to keep doing what they have previously done, even when not in their best interest (Kahneman et al., 1991). This bias describes how habitual behaviors persist but also why it is difficult to form new habits that are inconsistent with one's previous status-quo.

While behavioral science researchers generally take the individual as their unit of analysis, this does not mean researchers ignore social influences. A large body of work on social preferences has documented how people—unlike what would be predicted by a selfish economic model—care deeply about what those in their social network do, believe, and receive. While early research attempted to identify universal social preferences (Fehr & Schmidt, 1999), these social influences differ dramatically across cultural contexts (Henrich et al., 2005). Behavioral scientists now primarily focus on the cognitive mechanisms that result in a particular pattern of behavior within a social context. For example, social norms describe where an individual's actions are influenced by their beliefs of what others are doing and what others think they should be doing (Bicchieri, 2016). The fact that these expectations may be different for different social groups, and different for individuals having different reference networks within a social group, allows for the varied social preferences we see among people of different social groups.

Behavioral science insights have recently been deliberately incorporated into behavior change program design, including at the bilateral, national, and regional levels of government and non-government entities (Whitehead et al., 2019). Many applications of behavioral science have been to design a choice environment to nudge people to perform behaviors in their interest (Thaler & Sunstein, 2009). Nudges are intended to be consistent with libertarian paternalism, where each person's actual choices are not restricted, but their environment is designed to encourage a particular behavior. Nudges are often subtle changes, such as shifting the default offering or making one choice more salient. However, nudges represent only one area of the application of behavioral science to behavior change. Other applications of behavioral science incorporate rich insights from the program's target actors. They also often involve shifting entrenched social norms, such as encouraging the adoption of toilets (Ashraf et al., 2020), reducing female genital cutting (Evans et al., 2019), or encouraging treatment adherence to painful drug regimens like those used to treat tuberculosis (Yoeli et al., 2019). This latter set of interventions differs from traditional uses of nudges by addressing actors as members of a community rather than narrowly as individuals, being more overt about the intervention itself, and often targeting socially constructed practices.

In summary, the behavioral science perspective has studied how individuals make decisions, concentrating on the ways human behavior deviates from the predictions of rational choice models. The field has documented various biases that result from people relying on cognitive heuristics for making decisions, many of which are the result of quick, implicit, and sometimes emotional processes rather than slow deliberation. While this work analyzes decisions from the perspective of the individual, it also investigates social influences, showing how people process their social environment and then apply it to their choices. This work has recently been adopted into behavior change program design across various institutions and levels of decision-makers, sometimes within the framework of nudges and larger-scale behavior change campaigns that often target more entrenched behaviors.

The Social Science Perspective

While there is no single definition of social science, in this review, we take it to be the study of the relationship between social structure and decision making. The fields most associated with this research include anthropology, sociology, political science, and human geography.

This perspective recognizes that individuals do not make their decisions in a vacuum. Instead, social science puts social structure into primary focus. This includes how that social structure defines an individual's social identities and social roles, as well as how an individual's actions can feedback into shaping the social structure for themselves and the network in which they are embedded. From this perspective, this feedback system of socially defined identities and roles create the foundation for individuals to make choices (Popitz, 1972). While identity is often thought of as how individuals see *themselves*, the social sciences point to an even more critical component: the bidirectional relationship between how others perceive an individual and how that individual behaves. Common identities and accompanying roles addressed in the social sciences include gender, race, ethnicity, socio-economic status, and various culturally specific positions of power through prestige and authority. Both formal rules, such as laws, and informal rules, such as social norms, can dictate directly and indirectly how individuals of certain identities can or must behave, with that behavior then feeding back into socially defining those same rules (Hechter et al., 1990).

It is important to note that an individual can rarely, if ever, be reduced down to a single identity. For example, an individual might be both a woman and of a particular ethnicity. Their sum identity is reflected in the intersection of these various identities (Crenshaw, 1989). Understanding what intersections an individual inhabits is critical for understanding their behavior, as the social rules governing their actions apply differently for different intersections. For example, while women might generally be given minimal autonomy to make farming decisions, older women might have significantly more independence, pointing to the possible importance of the intersection of age and gender in understanding an individual's ability to act (Carr & Owusu-Daaku, 2016). There are various combinations of identities, and researchers have cautioned against the essentialization of an individual through a particular identity.

Much of the research in the social sciences has focused on how these various instances of social difference affect how a social group may restrict or enable agency through different forms of rules, and how those rules are socially constructed. Agency can be defined as the ability to make decisions to achieve one's current and future goals (Petesch et al., 2018). Indeed, agency is not distributed equally across populations; marginalized and lower-status groups experience less agency and decision-making power in society. This further results in groups having different abilities to make changes in their own lives or affect broader social systems. Some of these effects may be obvious on first observation, such as only men allowed in a particular space. Others may be far more subtle but can have major implications for behavior change. For example, female farmers in South Africa have less autonomy in setting their schedules, meaning they cannot make time to listen to scheduled radio broadcasts for agricultural forecasts (Archer, 2003). While research into the relations between different identity groups often focuses on where they "result in contradictory interests, imperatives and expectations" (O'Shaughnessy & Krogman, 2011), differing social groups may also mutually reinforce each other in complementary ways. For example, in eastern African bushmeat hunting, women reinforce hunting by men through encouragement and praise, plus benefit from their successes (Lowassa et al., 2012).

Scientists across the social and environmental sciences have been expanding the models we use that incorporate agency by going beyond individual actions to include strategic, political, and collective agency. This also aligns with shifts away from purely rational-actor models or Integrated Assessment Models that rely on narrow assumptions about human behavior. Such concepts help researchers explain and operationalize the influences humans can have on transforming systems, such as those required for global environmental change. For example, groups with greater agency tend to be those with greater wealth and those contributing more greenhouse gas emissions in daily activities. This has implications for how designers and scientists perceive leverage points within a system to change existing structures (Otto et al., 2020).

While different forms of relations exist, social scientists have found power between individuals of different social roles to be a particularly strong explanatory force for understanding human behavior. While analyzing these power dynamics within a community can be a fruitful lens, social scientists have also frequently applied this lens to the wider social system outside a given community. This often includes power dynamics between the behavior change implementer, such as a government agency, and those impacted by it. A social science lens can shed light

on phenomena such as why communities surrounding natural reserves area may refuse to comply with hunting regulations (Strong & Silva, 2020), or why someone might comply with an intervention designed to preserve free choice, even when the individual would not otherwise wish to comply (White, 2013).

Social scientists recognize that individuals are not just subject to social structures, but that they *constitute* those social structures as well. This creates feedback loops where one actor's behavior makes up another's social context. This can result in systems-level emergent properties, where the behavior of each individual can fundamentally only be understood by taking into account the behavior of the other actors in the system. This includes social tipping points, where changes among a minority can result in rapid group-wide changes in beliefs or behavior (Granovetter, 1978; Schelling, 1978). This work has been extended to understand how behavior adoption diffuses through social networks, in which each individual adopts a behavior only when a sufficient set of surrounding connected others do the same (Centola & Macy, 2007).

Taking this social-systems viewpoint often highlights the unintended consequences of a behavior change intervention that an individual-focused standpoint might miss. For example, interventions might have achieved their intended behavioral and environmental impacts but had negative impacts as well. Social scientists have pointed to unintended effects of strengthening bureaucracies (Ferguson, 1994), creating informal lines of employment such as interpreters and fixers (Jeffrey, 2010), or even undermining traditional authority structures (Beall, 2010). Understanding the totality of consequences has implications for how social scientists approach program assessment. They focus not only on the behavioral and environmental outputs but also on assessing any social impacts, intended or not, positive or negative, that may result.

The social sciences present a unique opportunity to evaluate the ethics of behavior change programming. One common but ethically questionable element of behavior change programming is its often top-down nature, where local stakeholders have no input into the programs they experience. As a result, programs can fail to recognize local communities' rights or simply be ineffective. A designer's lack of local knowledge results in a program being ill-suited for its target actors (Hansen, 2018). Because of their rich focus on the various identities among target actors, the social sciences have raised ethical concerns over the equitable distribution of a program's costs and benefits. While programs are often evaluated by estimating the average treatment effect for the entire population, the social sciences have focused on disaggregating these results to reveal disparate impacts.

Social scientists have further found justification to criticize the ethical nature of "nudge" style behavioral interventions, which are often invisible to target actors. Designers of this style of intervention often argue that their solutions preserve free choice and are not coercive. However, social scientists have pointed out that those subject to these interventions find a lack of disclosure to violate their autonomy, whether or not the designer finds it free-choice-preserving (White, 2013). Social scientists have also identified that these interventions rarely change the root structures of systems and problems they seek to address, even when they account for the social system in which they are deployed (Feitsma, 2018).

In summary, the social science perspective focuses on the actor as both the product and creator of their social context, rather than as an individual. This view recognizes the importance of the various social identities that an actor might have and how those identities dictate their position in the social system that defines their ability to adopt a behavior. By analyzing this system as a whole, a social science perspective can identify various ways in which actors might influence each other. These include power, allowing some to restrict the choices of others, or reinforcement, where some support others' ability to act. In the context of behavior change programming, this view can provide a critical lens on how powerful organizations, such as governments or NGOs, may, sometimes inadvertently, coerce target actors into compliance, which is ethically dubious. By looking at the total social system, this view recognizes the commonly inequitable distribution of costs and benefits from behavior change programming, often tying those inequalities to existing inequalities in the social system.

Review Focus and Scope

Presented this way, behavioral science and social science may appear quite different. However, both disciplines aim to explain human behavior and interaction. Instead of seeing them as fundamentally different, we argue that behavioral science and social science are best understood as two levels of analysis that exist on a spectrum (See Figure 2). This spectrum ranges from the most cognitive explanations of decisions existing entirely within the individual to the most abstract descriptions of social interaction focused solely on the system in which those individuals are embedded. Many sub-disciplines exist closer to the middle of this spectrum, blending these two perspectives, such as social psychology, cultural psychology, cognitive anthropology, and network analysis. By embracing this entire spectrum of behavioral and social science, we better understand human behavior as a whole.

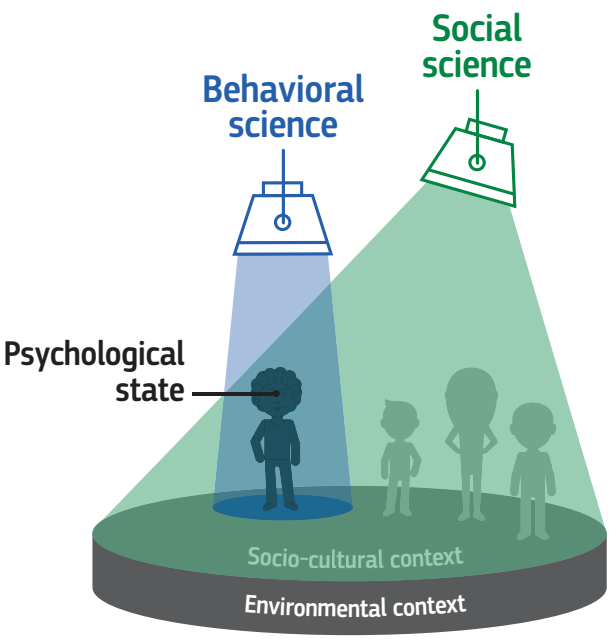

Figure 2. The interaction of behavioral and social science in understanding human behavior. Behavioral science focuses on understanding an actor's psychological state, whereas social science focuses on understanding the socio-cultural context for that actor. Both are necessary for understanding an actor's behavior within a given environmental context. Changes to the socio-cultural context, environmental context, or actor's behavior create feedback loops with one another.

In this review, we aim to identify how these perspectives can be applied to understand existing behavior change interventions designed to address biodiversity conservation, climate mitigation, water management and conservation, waste management, and land management. For each of these topic areas, we review empirical evidence for behavior change programs targeting behaviors in each of these areas. We include evidence that provides empirical analysis on the effect of interventions designed to change these behaviors, as well as evidence for the psychological, material, and socio-cultural barriers and motivations for their adoption. This includes evidence from the behavioral and social sciences, as well as non-disciplinary evaluations, and consists of both qualitative and quantitative analysis across a variety of measurement paradigms.

We then provide an analysis of that evidence in three areas. First, we review the evidence's strength for changes in the target behavior, including the internal validity, external validity, and geographic spread of the interventions. Then, we identify behavioral science insights demonstrated in the interventions or gaps in the intervention logic that behavioral science may elucidate. Last, we similarly identify social science insights in the interventions, including insights to help identify opportunities and gaps. After conducting this analysis for the five topic areas, we provide an overall summary of these analyses to identify trends across the environmental field. We conclude by proposing a framework for understanding how behavioral and social sciences can most effectively integrate into behavior change programming to improve environmental outcomes further.

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Waste Management

- Household Waste
- Consumer Waste
- Public Waste

Introduction

As human populations grow, so do the waste we produce. Current estimates of per capita per day waste generation are .74kg on average but can range from .11-4.54 kg depending on the country. As countries industrialize and urbanize, they generate more waste, with high-income countries being the largest waste producers. Waste management is one of the most critical services that towns and cities provide to their residents and are increasingly adding operations to manage both recyclable and compostable materials. Recycled materials represent about 16% of waste streams in low-income countries and 50% in high-income countries (Kaza et al., 2018). Plastic pollution has received significant recent attention due to its increasing presence in natural habitats, especially in oceans. It is estimated that plastic production has doubled every 11 years since 1950 and that there are 580,000 pieces per square kilometer in oceans (Law, 2017; Wilcox et al., 2015). The low rates of recycling, reusing, and properly disposing of waste also are problems around the globe in household and public settings. This topic covers three main areas of waste management: household waste, consumer waste, and public waste.

Analysis Highlights

- Many of the target actors for behavioral interventions already value and intend to reduce their waste and engage in recycling. Here we see a gap between intention and action, similar to that observed in *Topic 2: Climate Mitigation*. Effective and efficient interventions therefore include altering the architecture of the choice environment to make salient what choice would be consistent with their existing values and intentions, rather than attempting to change underlying motivations.
- Many of the most effective interventions for shifting waste management behaviors involve influencing habits. This can include interrupting existing habits to encourage reflection on other values or intentions or building new habits where the behavior reduces waste. This is consistent with the point above, where these interventions are effective precisely because they are consistent with existing values.
- The interventions covered in this section generally focus on altering the choice architecture and largely neglect other structural elements that would provide substantive support for engaging in the target behavior. While these changes are themselves behavioral, they involve changing the behavior of actors elsewhere in the system to make adopting better waste management practices materially easier for the target actor.

Household Waste

While waste management has many facets, targeting household waste offers significant promise in terms of scalable, adaptable solutions. These are behavioral interventions that focus on the waste management choices made by individuals in private at home (such as recycling and food waste), as well as those that reduce sources of waste coming into the household.

Reducing waste: Providing salient reminders and decision aids

Choice architecture interventions operate by changing the decision-making context, often in how choices are presented, framed, or prompted. Many interventions on waste management offer solutions that target those choices that people make out of habit. For example, an intervention in the UK was successful in increasing the

amount of collected food waste (from a compost bin rather than a trash bin) by 29.74% simply by placing stickers on people's trash bins that said, "No Food Waste Please" (Shearer et al., 2017). A simple solution that, with a cost of just 0.35£ per household, maintained its effectiveness for over four months.

Similarly, the Netherlands Nutrition Centre engineered a straightforward solution to another pervasive, but related problem: making too much food. The 'Eetmaatje' Measuring Cup, developed in partnership with the Dutch Creative Brands Group, aims to reduce food waste in Dutch households by making salient the exact quantities of rice or pasta need to feed different numbers of people (van Dooren et al., 2020). If used as intended, the cup has the potential to reduce food wastage by approximately 6% for pasta and 21% for rice. Between 2014 and 2019, 1.6 million free Eetmaatje cups were distributed to Dutch households. Of those provided with the cup, 77–87% reported that it helped them waste less pasta, with 50-80% stating that they used the cup most times that they prepared meals (van Dooren et al., 2020). The cup simplified choice for consumers through a nudge that helped make healthy and environmentally-friendly portion sizes salient and easy to achieve. Likely tied to more than just the Eetmaatje cup (though up to 7.9 million households could feasibly own one), the Netherlands has nonetheless witnessed a remarkable decrease in the amount of food waste: 0.73 kg of pasta and 1.45 kg of rice per person, between 2010 and 2019.

Prompts or reminders are tools that encourage behaviors that are different from those we perform habitually. Sometimes even just bringing attention to a decision can significantly impact the amount of waste we produce. Liebig and Rommel (2014), acknowledging that German households are often burdened by large amounts of unwanted junk mail, ran an intervention that encouraged people to attach "No junk mail" stickers onto their mailboxes. In the first of two treatments, researchers placed 'unattached' stickers inside people's mailboxes; in the second, they attached the stickers outsides of people's mailboxes, but only halfway stuck on. Because these stickers were only halfway stuck, the duo hypothesized that it would force consumers to actively decide between removing or fully attaching them (as opposed to being able to simply ignore it). Comparing the two treatments, Liebig and Rommel found that more than 21% of households in the forced-choice condition attached the "No junk mail," 5% more than if stickers were simply placed in mailboxes. Pairing these stickers with personalized messages and rewards for attaching them, as the team tested in a follow-up study, further increased sticker uptake and placement (Rommel et al., 2015).

Reducing waste: Social norms and comparison

The use of social norms can also be an effective way to promote green behaviors, particularly when people simply see the 'green' option as less attractive. There are several examples from Europe that demonstrate how people change in response to social pressure. In Poland, comparing the recycling performance of one's neighborhood relative to the national average had great success in encouraging households' willingness to pay for recycling services—particularly among those households that rarely recycled (Czajkowski et al., 2019). In Norway, a similar approach found that comparing individual performance to one's neighborhood increased recycling by 2% (Milford et al., 2015). In Sweden, the provision of leaflets highlighting descriptive norms to a 26% increase in food waste collection that sustained itself for eight months after the intervention (Linder et al., 2018). And in England, comparing the food waste of one's street with one's neighborhoods increased by 2.8% the likelihood that residents would put their food waste or compost bins out for collection (Nomura et al., 2011).

Social norms interventions are efficient and scalable in a variety of scenarios. They are, however, quite dependent on the ease with which the behavior of those in your reference network can easily be observed (Biccheri et al., 2020; Prentice & Paluck, 2020). Using mailbox stickers again as an illustrative example, Hamann et al. (2015) found that simply making existing anti-junk mail stickers more *salient* to neighbors by making them more visually obvious made those neighbors more likely to place the anti-junk stickers themselves. They also found that augmenting those stickers with a normative message that, as citizens, they should "engage in environmental protection and attach the accompanying anti-ads sticker to their mailbox" further boosted the effect. This demonstrates the critical nature of

not just providing vague messages about behavioral frequency but highlighting the real behavior of those engaging in the target practice in the relevant reference network.

Alternatively, intervention designers have found that public commitments, in combination with other tactics, can increase recycling. A study by Burn & Oskamp (1986) compared the effects of persuasive communication, public commitment, or a combination of the two to increase recycling rates in a Californian city. The results showed that 41% of households who received any of the treatments recycled at least once in the six weeks following the intervention as compared to 11% in the control condition. Another study compared signing a public pledge to recycle, receiving weekly feedback on pounds of recycled material, and receiving both interventions. The group who only committed did not change their behavior at all, whereas those who received feedback recycled 25% more. However, those who both committed to recycle more and received feedback recycled 40% more, demonstrating the importance of a multi-faceted approach (De Leon & Fuqua, 1995).

Reducing waste: Material incentives, social norms, and appealing to values

Finally, material and contextual constraints affect people's ability to properly reduce waste by means of recycling or composting. In an experiment in Peru, Chong et al. (2015) found no matter how recycling was framed, residents did not want to keep recyclables in their house because of the space it took and the fear that it would attract insects. Moreover, the separation of recyclables from general waste was generally associated with unofficial workers that residents stigmatized as 'scavengers.' For these reasons, simply providing residents with recycling bins was much more effective than any kind of messaging, be it information on environmental or social benefits, social comparisons, social sanctions, rule and regulation concerns, and reminders. This intervention made recycling more materially more convenient, reducing the time and effort required to perform the target behavior (for European example, see also Bernstad, 2014).

The effectiveness of incentives can further be shaped by existing norms, as in a case from Mexico on participation in communal litter collection. Offering a collective payment to a village (e.g., to support an annual festival), in fact, reduced participation relative to offering no payments—likely because of a lack of trust in local leaders (Kerr et al., 2012). On the other hand, if payments avoided authorities and went directly to individuals, or if the community had higher rates of trust in their leaders, participation increased. A similar intervention in Tanzania led participants to overwhelmingly express satisfaction when the task was either not rewarded or rewarded with a group donation to the village's school, but not when payments were offered individually. In fact, offering high individual payments led participants to report that they were unhappy with the payment level as well as the communal task they had just performed (Kerr et al., 2012). In both of these scenarios, different social norms led the communities to react very differently to material incentives. Beyond different perceptions of incentives, local contexts also shape how waste is perceived and valued. Whether waste management is seen as women's work in the house, a central city service, or a source of income, understanding what waste means to actors and stakeholders is an important part of intervention design.

Consumer Waste

Outside of the household, individuals create waste through their purchasing behavior. Behavior change interventions on consumer waste focus on point of purchase choices, encouraging a reduction in unnecessary purchases, packaging, and accompanying waste generation.

Reducing plastic bag use: Providing negligible incentives

Every year, the world uses between 500 billion and 1.5 trillion disposable plastic bags (Clapp & Swanston, 2009). Recently, levies, or taxes, have become increasingly prevalent. As of 2017, at least 127 countries had some sort of regulations on plastic bags of varying restriction levels (UNEP, 2018). In England, a £0.05 plastic bag tax was

introduced to try and reduce the use of disposable, single-use plastic bags. Despite the relatively small increase in cost, plastic bag use declined from 57% to 29%, and the use of reusable bags increased (Thomas et al., 2019). The policy became more popular after its introduction, much like it did in Ireland, where it reduced plastic bag usage by over 90% (Convery et al., 2007). Longitudinal analysis revealed that those who increased their support for the plastic bag tax also increased their support for other similar policies to reduce plastic waste.

Portugal also introduced a successful plastic bag tax in 2015 (Martinho et al., 2017). Four months after its implementation, there had already been a 74% reduction in the consumption of plastic bags, combined with a 61% rise in the use of reusable bags. An unintended effect of the tax, however, was that whereas people used to 'recycle' plastic 'grocery' bags as bin liners, they now increased their purchasing of garbage bags by 12% (Martinho et al., 2017)—an effect that had also been observed previously in Wales (Quested, 2013). Moreover, when asked about their opinion of the tax, the majority of people stated that though they agreed with it, they still viewed it as a source of extra revenue for the Portuguese state.

A city-wide $0.05 tax was introduced in Toronto in mid-2009, but the effects were lower than those in Europe (Rivers et al., 2017). Researchers found that the intervention had only increased the use of reusable bags by 3.4%. This was a smaller effect than those observed in other studies. One reason could be the study's difference-in-difference approach, which effectively controlled for country-wide changes in environmental attitudes and preferences. Without that control, the increase was estimated at 22%. The other studies' pre-post analyses may have positively biased what is otherwise a much smaller plastic bag tax effect.

Studies have also explored how the framing of plastic bag taxes could increase or hinder their effectiveness at swaying consumer behavior. For example, Muralidharan and Sheehan (2016) found that the framing to utilize a reusable bag has a significant impact on the choices that consumers made. Specifically, informing shoppers that they would be 'paying a tax' for using plastic bags appeared more effective than encouraging shoppers to "avoid a fee" by utilizing reusable bags. In a similar vein, an intervention in Maryland's Montgomery Country, USA, found a $0.05 plastic bag tax to be almost 40% more effective at reducing the use of plastic bags than a $0.05 bonus for the use of reusable bag early (Homonoff, 2018). In both cases, presenting the tax as a loss was significantly more effective than presenting it as a gain (i.e., the bonus or the fee avoidance). This supports the assertion that the effect of plastic bag taxes is not due to their shift in material incentives, as both a tax and a bonus offer similar monetary effects.

Whereas high-income countries have used plastic bag taxes due to public pressure and growing green norms, low-income countries have instead relied on government-enacted plastic bag bans driven by the direct harm of excessive plastic use (Knoblauch et al., 2018). In 2011, Nepal introduced a municipality-driven ban on plastic bags because of the growing threat that plastic posed for the country's wellbeing (Bishal Bharadwaj, 2016). In Botswana, both a ban and a tax were introduced for bags that fell below 24 microns of thickness (Dikgang & Visser, 2012; Mogomotsi et al., 2019). In 2017, Kenya introduced what is widely seen as one of the strictest plastic bans in the world. But where reusable bag ownership has increased when shopping patterns support it (i.e., in urban centers), a recent survey revealed that this effect was mostly concentrated among low-income or female city residents (for similar effects in China and Malaysia; e.g., He, 2012; Zen et al., 2013). In fact, only around 42% of survey respondents actually brought their own reusable bags when shopping (Omondi & Asari, 2019).

In South Africa, where a plastic bag ban was used in combination with a small levy, researchers initially reported a decrease in the use of plastic bags of around 70% in the first three months (Dikgang et al., 2012a). Unlike the European examples of plastic bag taxes, however, these effects were only short-lived. Though the fee was universal at first, the price for plastic bags soon differed between retailers—hampering the government's efforts. As people became accustomed to paying different amounts for the bags, the initial sense of loss that consumers felt largely faded, and there has since been a true rebound in the consumption of plastic bags as their use per capita steadily

increases (Dikgang et al., 2012b). A more recent study by O'Brien and Thondhlana (2019) finds that this rebound is largely due to the fact that plastic bags remain the most convenient option, in addition to still being widely available and affordable. They suggest making alternatives as appealing—perhaps by providing reusable, environmentally-friendly bags for free (as plastic bags once were) or by not selling carrier plastic bags at the till (i.e., keeping them elsewhere in stores that is less convenient). Tests showed that the plastic bag problem in Delhi, where almost 94% of citizens continued to use bags despite a ban, could be reduced by providing customers with an inexpensive alternative and a cash incentive (Gupta, 2011).

Reducing plastic waste: Social norms

While bans and taxes have become commonplace, social influences offer a complementary tool for reducing waste. For example, an intervention in a Parisian supermarket looked at the effects of asking shoppers to endorse and sign a poster advocating for 'not using plastic bags' (Rubens et al., 2015). The endorsement served as a commitment mechanism, making shoppers 29% less likely to take free plastic bags if they had signed the poster. Alternatively, researchers have leveraged normative messaging. In an exploratory field-study, De Groot et al. (2013) found that injunctive and personal norm messaging could be used in conjunction with informational environmental messages to successfully reduce the use of plastic bags in UK supermarkets.

Variants of the above interventions have also been used for waste issues that go beyond the problem of plastic bags. A study by Schmidt, in 2016, found that public commitments, combined with intention planning, could lead consumers to better plan for grocery shopping and therefore reduce excessive food wastage. Similarly, norms messaging has been found to be effective at reducing the use of disposable plastic water bottles (Santos et al., 2016; van der Linden, 2015), and in encouraging the use of reusable takeaway boxes at restaurants (Dorn & Stöckli, 2018). Importantly for future program design, a norm message appeared to have no effect, whereas direct observation of the norm—i.e., other customers using reusable takeaway boxes—increased the odds of making a similar decision nearly six-fold.

Reducing product waste: Altering the context of the choice

A final grouping of interventions to address consumer waste involves altering the choice context. The way choices are presented to consumers influences both how and why they ascribe value to a given option. For example, priming consumers to think about protecting the environment while shopping has been found to increase the selection of unpackaged groceries relative to packaged ones regardless of a shopper's personal attitude towards the environment (Tate et al., 2014). In a laboratory experiment, Stefansdotter and her colleagues (2016) found that they could nudge potential phone buyers into making greener choices by simply altering the way in which their options were presented. While most vendors typically only present customers with the option to purchase a new phone, the experiment explored the impact of also actively offering customers the option to purchase a used phone (or to simply get one's screen repairs). Where only 4% of customers typically chose to buy a used phone, 29% made that choice when the 'green' alternative of purchasing a used phone was actively offered. For screen repairs, the corresponding percentages were 87% when actively offered, and 67% when not.

Some countries are adding labels to products to prompt consumers to think about their longevity. Across six European countries, the addition of 'lifespan' labels to various products such as suitcases, printers, trousers, sports shoes, coffee makers, washing machines, vacuum cleaners, and smartphones increased the purchase of longer-life products by 13.8% (SIRCOME et al., 2016). Consistent with the labels focusing consumer attention on lifespan, the effectiveness of the labels depended on the perceptions of lifespans for different products. For example, the lifespan labels made a greater difference in suitcase purchases than televisions, given the expected length of use of each.

The way in which 'green' options are labeled also has an impact on consumer choice. For example, using familiar labels to describe eco-friendly disposable dinnerware makes them more appealing to customers with labels like 'no plastic' and 'recyclable.' In contrast, obscure labels such as 'made from agricultural crop byproduct cellulose,'

'cellulose from dedicated crops/organically sourced cellulose,' 'certified biobased,' 'compostable,' and 'uses no trees' were less appealing (Gill et al., 2020). The significance of these labels can also impact how much food we waste. One study found that highlighting that cafeteria waste will be composted can, in fact, backfire and *increase* wastage (Qi & Roe, 2017). If the negative impact that people attribute to waste is reduced, people worry less about wastage. People care about the type of waste that they produce and change their consumption decisions towards what they feel is less destructive.

Public Waste

The last section of waste management focuses on public waste and littering. Waste management in these settings is an important part of keeping public spaces clean and enjoyable for residents as well as reducing pollution in local waterways. These interventions focus on waste management decisions that support people in recycling, reducing waste, or disposing of waste properly in public.

Increasing recycling and decreasing littering: Incentives, decision aids, and prompts

A number of studies highlight the effectiveness of increasing the ease of recycling and disposing of waste properly in public spaces. For example, McCoy et al. (2018) found that by adding and relocating recycling bins to increase their prominence, they could, in fact, increase recycling efficiency by 23% on a university campus (and decrease the number of recyclables in the trash by 13.38%). In another study, providing more bins was as effective as asking people to plan recycling behavior in advance—the former redirecting a habit, the latter interrupting it (Holland et al., 2006). Additionally, placing specialized lids on recycling bins that have the shape of the recyclable items they accept has been found to further sway our decisions towards 'greener alternatives.' A field study found that specialized lids served to both deter non-recyclable items from being placed in the wrong bins and to make more salient those items that should be recycled (Duffy & Verges, 2009). The presence of these lids increased recycling rates by 34% compared to those bins without specialized lids, and the number of bins that contained non-recyclable items was reduced by 95%.

Defaults to Decrease Paper Waste

Paper waste in office and university settings can create both a drain on natural resources and supply budgets. Defaults, one of the core tools of choice architecture, have successfully mitigated paper waste in university settings. A study in computer labs at Rutgers University explored making double-sided printing the default option on computers to save paper. Over the course of three years, the intervention led to a 44% decrease in paper usage from this one setting change, the equivalent of saving 4,650 trees. A Swedish university replicated this intervention and observed a 15% immediate and lasting reduction in paper usage. These solutions are also more effective than a 10% tax on paper products, which has only demonstrated a 2% decrease in paper consumption (Egebark & Ekström, 2016; Sunstein, 2016).

Other visible interventions for reducing waste have taken the form of symbols and prompts in the environment. Guiding pedestrians to waste bins via green footprints printed on the ground has been shown to be effective in both Copenhagen, where it reduced littering by 46% (iNudgeyou, 2012), and in a number of English cities, where littering dropped 15.9% (Keep Britain Tidy, 2015). In China, researchers found that they could reduce littering in a factory by over 20% by placing gold coin decals, a culturally important sign of good fortune, on the shop floor (Wu & Paluck, 2018). This was more effective than previous attempts at rules, reminders, and monetary penalties. The intervention lost its effectiveness if these decals were removed and reintroduced—likely because easily taking the decals away revealed to workers that these were not as meaningful as once thought. At Indian informational technology firms, an intervention to limit unnecessary printing involved posted signs near printers and around the office as reminders. These also invoked an injunctive norm with a sad face to provide a social signal supporting behavior change. The intervention reduced per person daily paper wastage in the firms who received the reminders by 4-6 sheets compared to firms in the control condition (Chakravarty & Mishra, 2019).

Analysis

There are many parallels between interventions that target waste management and those that tackle climate mitigation (see *Topic 2 Climate Mitigation*). One of the biggest trends in this section on waste management is that people's intentions do not match their actions. This gap between intentions and actions also tends to be very context-dependent; the barriers to reducing household waste are often very different from those that we face as consumers or in public settings. Likewise, waste is perceived and experienced very differently in different parts of the world. The challenge for behavior change designers is translating intentions into actions for a wide range of actors.

Review of the strength of the evidence

The most common technique for encouraging improved waste management is the use of material incentives, mainly taxes and bans. In fact, because of the sheer quantity of such interventions, plastic bag taxes and bans dominate the evidence base. The most promising results from such programs come from pre-post comparisons (Convery et al., 2007; Martinho et al., 2017; Thomas et al., 2019), but these have a less robust intervention design. The results from more experimentally-sound evaluations have recently highlighted how the lack of internal validity in such pre-post assessments creates inflated outcome reporting (Rivers et al., 2017). While results from plastic bag tax and ban interventions should be interpreted with caution, small incentives like these help to draw attention to choices otherwise made out of habit, leaving them open to powerful framing effects (e.g., Homonoff, 2018; Muralidharan & Sheehan, 2016). Whether these effects are long-lasting, however, remains a matter of debate (Dikgang et al., 2012a, 2012b; Rivers et al., 2017).

Except for the plastic bag policy interventions (i.e., taxes and bans), interventions to reduce waste are most frequently evaluated with internally-valid experimental methods. Such methods increase our confidence in the strength and significance of their results. Moreover, the majority of evidence is based on field interventions, with a minority coming from lab-based hypothetical choice experiments. Field-based studies provide a high degree of ecological validity, as minimal assumptions are required for inferring whether these insights apply to target behaviors in a natural setting. We thus find reliable and credible results for interventions that leverage social influences (often through normative messaging; e.g., Czajkowski et al., 2019; Nomura et al., 2011) and for those that make waste-reducing choices easier and more salient (Duffy & Verges, 2009; SIRCOME et al., 2016). The use of descriptive norming (where an individual is given feedback about what others are doing and how their behavior compares) has been found to be effective at increasing proper handling of waste in the household (Czajkowski et al., 2019; Linder et al., 2018; Milford et al., 2015; Nomura et al., 2011). While few of these interventions were evaluated for durability across time, those that were evaluated months after first being implemented had a persistent effect (e.g., Hamann et al., 2015). The same is true for choice architecture interventions that subconsciously alter the context of the decision. These interventions are often inexpensive to administer, making them cost-effective even with seemingly low but significant behavior adoption rates. Choice architecture interventions were found to be effective for months

when the cues remained in place (e.g., Egebark & Ekström, 2016; Keep Britain Tidy, 2015; van Dooren et al., 2020), but few evaluate the durability of the effect after those cues were removed.

Interventions in this section are most often from high-income countries, particularly in Europe. We find Northern Europe to be over-represented. Given that these interventions are most frequently carried out by local government authorities, this is likely a reflection of relative policy priorities. These interventions would need to be replicated with a more globally representative population for us to be confident in generalizing their results beyond those geographies and across varying socio-ecological dynamics.

Review of the application of behavioral science

One important phenomenon to consider for waste and pollution is that target actors will most likely face intention-action gaps. People's intentions, attitudes, or values do not always reflect in their actions (Blake, 1999). Even though people claim to want to reduce the waste they create, they do not take steps to do so (Barr, 2006; Chung & Leung, 2007). Our choices relative to waste are often subconscious and guided by habits, and choices that generate more waste are often cheaper, easier, and available. Many of us accept and rely on plastic bags at the grocery store, either by habit or because they represent the fastest option at our disposal.

As a result, social norm interventions work because they make waste decisions about social trends and expectations, not just price and convenience. When told that 'most people do it this way,' decision-makers want to conform. A visible norm in favor of waste-reduction encourages greener decisions by placing a social 'cost' on those behaviors that are outside the norm (Czajkowski et al., 2019; Dorn & Stöckli, 2018; Nomura et al., 2011). Social norms also signal what others expect from you, yet practitioners must be mindful of existing norms as well (Kerr et al., 2012). Public commitments appear to be effective because by committing to waste-reducing actions publicly, consumers now have the added pressure of meeting that commitment in front of other members of their community (e.g., De Leon & Fuqua, 1995; Rubens et al., 2015; Schmidt, 2016).

Additionally, interventions that work with or interrupt habitual decision-making also prove useful because they make waste-reducing decisions active and easy. People will intuitively follow simple prompts that guide them towards making better waste decisions. Examples range from green footprints printed on the ground (iNudgeyou, 2012), to object-shaped waste bin lids (Duffy & Verges, 2009), to easy-to-use measuring cups (van Dooren et al., 2020). These are simple choice architecture efforts that streamline our decisions and make salient the 'recommended' choice. They remove some of the *behavioral friction* that might otherwise widen people's intention-action gap. Intervention designers can also leverage people's status quo bias (i.e., our tendency to stick with current options) to design interventions that 'pre-select' waste-reducing options as defaults (Chakravarty & Mishra, 2019; Egebark & Ekström, 2016).

Where intervention designers may not have the option to enforce defaults or shape the decision context, another effective option has been to actively encourage choices that reflect intentions. Such interventions include prompting a change in behavior through reminders, emphasizing new information (Shearer et al., 2017; SIRCOME et al., 2016), or forcing an active choice (Liebig & Rommel, 2014; Stefansdotter et al., 2016). These are simple yet effective strategies because they pause decision-makers to rethink habits or following the status quo.

Currently, single-use plastic interventions rely on an increase in price to change behavior, yet little research has been done to make choosing the alternative easier and more convenient (Dikgang et al., 2012b; O'Brien & Thondhlana, 2019; Gupta, 2011). Moreover, the tax may have changed how consumers perceive plastic bags, but decision-makers still need to plan to carry a reusable bag with them while shopping, which has its own barriers.

We identified very few behavioral interventions involving air or water pollution as waste, and those have been covered in the *Agricultural Land Management* and *Water Management & Conservation topics* (cf., Duflo et al., 2013).

We suspect this lack of research is due to a failure to apply behaviorally informed approaches to corporate actors, who are perceived as different from consumers or rural producers. However, actors within companies are subjects to the same behavioral influences as demonstrated by multiple waste management interventions in the public context (Chakravarty & Mishra, 2019; Holland et al., 2006; Wu & Paluck, 2018).

Review of the application of social science

Issues surrounding waste, though global, are highly specific to the communities in which practitioners need to intervene. Many of the interventions in this section have visible outcomes that materialize in people's daily lives. This is an advantage for behavior change practitioners, as it allows us to bring behavioral interventions more easily into the physical world (e.g., iNudgeyou, 2012; Keep Britain Tidy, 2015; van Dooren et al., 2020). It also leads many intervention developers to consider more deeply the cultural context in which interventions are deployed and to gain a better understanding of the unique norms and values that can reinforce or impede behavior change efforts. Interventions aimed at encouraging litter pickup, for example, can have very different outcomes based on the socio-cultural context in which they are deployed. In Mexico, rewarding litter collection efforts through communal payments to one's village proved highly ineffective because certain communities do not trust their local leaders. In Tanzania, collective payments overwhelmingly led to workers' satisfaction following litter collection (Kerr et al., 2012).

The heterogeneity of community norms and their effects on people's behavior is integral to the design of behavior change interventions. Wu and Paluck's (2018) golden coin intervention stands out as a case study for how a deep dive into communities' norms can support more tailored solutions. Having identified that Chinese factory workers associated golden coins with fortune and luck, the team endeavored to make littering about more than a simple waste issue by placing decals of golden coins all over a textile factory's floor (Wu & Paluck, 2018). Because of the cultural norms associated with the coins, workers became self-motivated to respect the symbolism and keep the golden coins clear of waste. This was true until the coin decals were removed then reintroduced, and the symbols became less permanent and sacred.

Where the interventions in this section do a great job at swaying consumer behavior, there have been no efforts to target actors further up the supply line (plastic bans notwithstanding). Behavioral and social scientists are uniquely positioned to target the behavior of sellers and producers. Yet, most of the interventions here focused on consumers changing their behaviors within larger market forces. The few interventions that deviate are those that highlight how providing easy and sustainable alternatives to plastic bags may help in lessening the pull of cheap and convenient plastic (e.g., Gupta, 2011; O'Brien & Thondhlana, 2019). We suggest intervention designers focus their efforts on interventions that reduce waste systematically at the source rather than solely encourage waste recycling. This would mean adopting a systems-based approach that considers waste management behaviors throughout the production and consumption lifecycle of waste products.

As a complement, the evidence-base also points to simple 'ease of access' interventions that target systematic changes without much effort. For example, Chong et al., (2015) thought that Peruvians' negative attitudes towards recycling were socially driven (i.e., that recyclers were seen by the community as 'scavengers'), but they also found that for many, the lack of accessible bins was the root of the issue. No matter how many behavior change interventions the team tried (normative appeals, timely reminders, social sanctions), households did not want to keep recyclable waste around the house and risk attracting insects. The bins were a cheap and easy way to alleviate these concerns and encourage recycling. Similarly, on US campuses, simply relocating recycling bins to increase their prominence can lead to effects similar to adding specialized bin lids (Duffy & Verges, 2009; McCoy et al., 2018).

On ethics, waste management interventions remain true to the libertarian paternalism roots of nudging. Most interventions aim to maintain people's freedom of choice, and intervention outcomes are designed to support people's best interests. Only very rarely do we identify problematic and unequal dynamics between implementors and target actors. The main difference we found was between high-income and low-income countries in terms of

plastic bag bans and taxes. As mentioned previously, high-income countries tend to adopt plastic bag taxes (not bans) as an environmentally-friendly reaction to public pressure. In low-income countries, plastic bag bans (not taxes) are imposed as a reaction to the visible and harmful effects of plastic on the environment, regardless of public opinion (Knoblauch et al., 2018). The effect of policymakers' decisions has resulted in restricting the choices of those in low-income countries while preserving the right to choose in the high-income countries, which is a pattern of effective discrimination we find troubling.

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