



# Biases and nudges in the circular economy: A review

Luca Congiu<sup>a</sup>, Enrico Botta<sup>b</sup>, Mariangela Zoli<sup>c,\*</sup>

<sup>a</sup> Department of Economics and Finance, Tor Vergata University of Rome, and Insubria Experimental Economics (InExEc) research center, University of Insubria, Italy

<sup>b</sup> Environment Directorate, Organisation for Economic Co-operation and Development (OECD), France

<sup>c</sup> Department of Economics and Finance and Center for Economic and International Studies (CEIS), Tor Vergata University of Rome, and Sustainability Environmental Economics and Dynamics Studies (SEEDS), Italy

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## ABSTRACT

The circular economy transition requires consumers to make efforts in their waste disposal behaviors by increasing waste sorting, repairing and reusing products, and reducing the amount of waste produced. The literature has identified several barriers to consumers' adoption of these practices. In this article, we posit that such barriers can be ultimately linked to well-known decisional biases and proceed to offer a review. In doing so, we categorize biases into "cognitive", referring to deviations from judgment and behavior that would be "correct" according to the rules of logic and mathematics, and "motivational", encompassing judgment and behavior driven by desirability concerns. We also survey the existing behavioral policies addressing the identified biases, focusing on "nudges", that is, interventions leveraging biases to improve welfare. In our review, we call attention to the importance of recognizing the relevant bias behind specific behaviors to identify the best interventions to implement. By offering a conceptual link between biases and circular economy practices, we also lay the groundwork for future experimental investigation.

## 1. Introduction

The ecological transition implies reconciling economic growth and environmental preservation with the core objective of providing benefits to all while remaining within the planet's ecological limits. Different approaches have been proposed to maintain the use of natural resources at a sustainable level (Figge and Thorpe, 2023). Among them, the circular economy (CE) paradigm aligns with the objectives of the ecological transition by closing resource loops through the repeated use of resources, which in turn minimizes the necessity for virgin materials and ideally creates no waste (Korhonen et al., 2018; Rotondo et al., 2022; Chembessi et al., 2023). Specifically, CE aims to shift the current linear economy, based on the concept of take-make-dispose, towards a circular model that reduces the consumption of material resources by recovering materials from waste for recycling or reuse, using products longer, and harnessing the potential of the sharing and services economy.<sup>1</sup>

Achieving the transition to CE requires huge efforts from all different economic actors. This includes consumers, who are urged to

make further endeavors in performing actions they already make, such as improving waste sorting. In some cases, they are even required to change their attitudes and behaviors, such as when the adoption of new and alternative consumption models is implied. Despite the relevance of consumers' involvement in enabling the CE transition, the scientific research on the reasons why consumers are reluctant to participate in CE processes is still scant (Georgantzis Garcia et al., 2021; Vidal-Ayuso et al., 2023). In this article, we contribute to closing this knowledge gap by focusing on specific individual behaviors relevant to achieving the CE transition, namely reducing waste generation, reusing/purchasing second-hand products, and recycling.<sup>2</sup> These behaviors are part of the priority actions outlined by the hierarchy of circular strategies and the 10R strategies to reduce resource and material consumption and promote the implementation of CE.

We posit that the different factors explaining why individuals are reluctant to adopt these behaviors can ultimately be linked to decisional biases that are well known in the behavioral economics literature. Broadly speaking, "biases" entail systematic departures from the prescriptions of standard economic theory due to cognitive, social, or

\* Corresponding author.

E-mail addresses: [luca.congiu@uniroma2.it](mailto:luca.congiu@uniroma2.it) (L. Congiu), [enrico.botta@oecd.org](mailto:enrico.botta@oecd.org) (E. Botta), [zoli@uniroma2.it](mailto:zoli@uniroma2.it) (M. Zoli).

<sup>1</sup> <https://www.oecd.org/environment/trade-resource-efficiency-circular-economy.htm>.

<sup>2</sup> The concept of CE is highly debated in the literature, with no commonly accepted definition, as testified by several contributions (Kirchherr et al., 2017, 2023). Most frequently, CE is depicted as a combination of reduce, reuse and recycle activities in production, circulation, and consumption processes. This article focuses on these activities only from a consumer-centered perspective.

emotional motives (e.g., [Tversky and Kahneman, 1974](#); [Camerer and Thaler, 1995](#)). What we do in this article is start from the most relevant biases identified in the literature, survey the contributions on CE behaviors (reduction, reuse/repair, and recycling), and suggest potential links between the factors that discourage individuals from taking specific actions in support of the CE transition and the different biases. We ultimately argue that understanding the specific biases behind CE behaviors is essential to designing well-tailored policy interventions.

To structure our review, we adopt the taxonomy that classifies biases as “cognitive” or “motivational” ([Montibeller and von Winterfeldt, 2015](#)). Generally speaking, “cognitive biases” denote deviations from “correct” judgment or behavior, that is, one that accords with the laws of logic, mathematics, and probability; “motivational biases” refer to situations in which judgment or behavior is distorted by concerns of desirability or undesirability with respect to the decision outcomes.<sup>3</sup>

In addition to reviewing decisional biases, we also survey the behavioral policies that can address them. In doing so, we focus on “nudges” ([Thaler and Sunstein, 2009](#)). According to the most recent literature (e.g., [Berthet and Ouvrard, 2019](#); [Congiu and Moscati, 2022](#)), nudges can be defined in a broad sense as private or public interventions in the decisional context that steer people’s decisions without restricting freedom of choice, unlike bans and mandates (e.g., [Sunstein, 2015, 2018](#)). In a narrow sense, nudges can be seen as aspects of the choice context steering people’s behavior by acting instrumentally on biases, boundaries, routines, and habits rather than some form of economic incentivization or “rational” argumentation ([Hansen, 2016](#); see also [Mongin and Cozic, 2018](#) for a similar definition). All the interventions we will review in the following are consistent with Sunstein’s broad definition of nudge and, with a few exceptions, with Hansen’s narrow definition.<sup>4</sup>

Our contribution is certainly not the first to offer a review of the determinants of waste behaviors and the interventions to foster them, but it differs from and complements other surveys in several respects. First, these contributions have focused on a specific waste behavior or material. For instance, the systematic reviews by [Varotto and Spagnolli \(2017\)](#) and [Zhang \(2023\)](#), and the non-systematic ones by [Kirakoziyan \(2016\)](#) and [Knickmeyer \(2020\)](#), focus on uncovering determinants of waste recycling at home and/or policies that can foster it. Similarly, other reviews in the literature have restricted their attention to food waste behaviors (e.g., [Stangherlin and De Barcellos, 2018](#)) and the effectiveness of nudge interventions to reduce it (e.g., [Zhang et al., 2023](#)), or have surveyed interventions aimed at reducing plastic waste production (e.g., [Allison et al., 2022](#); [Mathew et al., 2023](#); [Trushna et al., 2024](#)). By contrast, our review is not limited to waste sorting

but extends to waste reduction and reuse/second-hand consumption — practices that have received less attention in the literature — while also distinguishing diverse materials and products (e.g., clothing vs. electronic devices).

Second, some contributions devote more attention to the potential interventions that can foster waste behavior rather than its individual determinants. For example, [Kirakoziyan \(2016\)](#) reviews the literature assessing the effectiveness of the main incentive-based and behavioral policies on recycling behaviors, and [Varotto and Spagnolli \(2017\)](#) provide a systematic review and meta-analysis of field interventions to promote household waste sorting at home; both contributions only touch upon some individual determinants that can be targeted by these policies. In contrast, in our review, we cover both biases and nudges equally, in a synergic spirit.

Finally, and most importantly, reviews that investigate individual determinants of waste behavior do not purport to identify decisional biases, or they do it only in part. For example, [Zhang \(2023\)](#) finds that intentions, norms, and knowledge are the most widely investigated drivers of CE practices. [Singh and Giacosa \(2019\)](#) and [Knickmeyer \(2020\)](#) cover biases that are relevant to the circular economy, but the former work focuses only on some of the cognitive ones and the latter touches on social norms, that is, a subset of motivational biases. The contribution by [Singh and Giacosa \(2019\)](#) is arguably very close in spirit to ours, as it conceives of cognitive biases as unifying mechanisms to explain why circular business models often fail to align with consumers’ interests and values. Despite this similarity, we depart from it — and also from that by [Knickmeyer \(2020\)](#) — by considering a broader set of biases and distinguishing between cognitive and motivational ones. Furthermore, differently from [Singh and Giacosa \(2019\)](#), we also review the main behavioral interventions suggested by the literature to address each identified bias.

Indeed, it is the perspective centered on biases and their close link with the proposed interventions what differentiates the most our review from the others in the literature on waste behavior. Our approach starts from the biases identified by the behavioral literature and attempts to uncover which CE behavior is affected by each category of biases, with the aim of identifying which ones may hinder the adoption of CE practices and why. To do so, we interpret the factors that can hinder or encourage CE behaviors, as highlighted by the literature, in light of the concept of bias, which can be considered as the conceptual framework guiding our analysis. Setting a bias as a focal lens for our analysis in place of a specific waste behavior allows us to cover all CE practices in a comprehensive manner and capture whether and how each bias affects them, ultimately identifying potential analogies and differences. In addition, the focus on the main biases in the literature allows us to identify and propose the intervention that is more appropriate and effective to address each specific bias, as informed by the relevant literature.

This approach also motivates the non-systematic selection of the articles mentioned in this review.<sup>5</sup> The exploratory character of our review is called for by the following two observations. First, as already noted, very rarely does the literature on CE explicitly refer to biases to explain why specific individuals’ actions do not align with the CE objectives. Neither does it refer to the specific leverage through which an intervention works (and then implicitly to what kind of bias it

<sup>3</sup> Biases can be classified in several ways, each serving its specific purpose. Some contributions separate the activity of “judgment” from the one of “decision” (or “behavior”) and implicitly do the same for the biases underlying either activity, such as the behavioral economics textbook by [Angner \(2021\)](#) and, to a lesser extent, that by [Dhami \(2020, volume 5\)](#). [Gagliardi \(2025\)](#) focuses on judgment biases and distinguishes them between those involved in “belief formation” and those in “belief updating”. [Mullainathan and Thaler \(2000\)](#) advance a tripartite classification based on whether biases refer to cognitive limitations (“bounded rationality”), lack of self-control (“bounded willpower”), and other-regarding preferences (“bounded self-interest”). We believe the classification by [Montibeller and von Winterfeldt \(2015\)](#) is better suited for understanding CE behaviors.

<sup>4</sup> While the broad definition can successfully separate nudges from bans, taxes, and mandates, that considerably alter one’s economic incentives and freedom of choice, it fails to separate them from softer traditional interventions, such as those that provide factual information and/or only slightly alter one’s economic costs. In effect, four categories of interventions reviewed in our article do not fall within the narrow definition of nudge (namely, selectively framing benefits of refill solutions in safety vs environment terms; providing reusable bottles for free; increasing accessibility of jeans repair; actively offering green smartphones alongside traditional ones), but they are still compatible with the definition of nudge in the broad sense.

<sup>5</sup> The selection was done first by searching by some general keywords on the most relevant engines for peer-reviewed scientific literature; then, the search was expanded by including references from the reviewed articles that were most promising for the conceptual framework of the study. This approach is similar to the one adopted by [Knickmeyer \(2020\)](#), who carries out an exploratory (non-systematic) literature review by searching scientific databases using first some general keywords and then expanding the search with more specific keywords and using the references provided by the reviewed papers. Other non-systematic reviews, like [Kirakoziyan \(2016\)](#), do not explicitly specify the inclusion criteria.

addresses). Thus, underlying biases have to be inferred by studying the context of the behavior, the potential explanatory factors, and, in several cases, the kind of intervention adopted to stimulate a behavioral change and the mechanisms driving its impact, as they are often specific to addressing a precise bias. Conducting a search using the category of biases as keywords would have entailed missing most contributions simply because they do not explicitly recognize and mention the bias affecting individual behaviors. Given the aim of our work — investigating the potential links between decisional biases and the barrier to circular practices — we believe that adopting an explorative approach is more appropriate than conducting a systematic review. In effect, the contributions surveying decisional biases are typically non-systematic in nature (e.g., Caputo, 2013; Kumar and Goyal, 2015; Saposnik et al., 2016; Wattanacharoensil and La-ornual, 2019; Singh and Giacosa, 2019; Gagliardi, 2025).<sup>6</sup>

Second, differently from other types of analysis and in line with the exploratory character of reviews on biases, we do not need to summarize all the scientific evidence about, for instance, a specific (waste) behavior or bias. Contributions that conduct systematic reviews or meta-analyses need to focus on a specific issue to adequately synthesize the mass of scientific evidence around it, such as the effectiveness of interventions that foster the demand for bio-degradable bags (Adeyanju et al., 2021) or food waste reduction (Schanes et al., 2018; Zhang et al., 2023). In contrast, considering the purpose of this article, we contribute by providing only some suggestions that may be illustrative of the potential role of each bias on the different behaviors relevant to CE and the related interventions.

With these clarifications in mind, we can now proceed with the review. It is structured as follows. Section 2 covers the main cognitive biases that underlie CE behaviors and the nudges that can address them. Section 3 similarly reviews motivational biases and related nudges. Section 4 draws some conclusions from the literature review and suggests potential avenues for future research.

## 2. Cognitive biases and nudges

Cognitive biases involve deviations from judgments and behaviors that would be consistent with what the laws of logic, mathematics, and probability prescribe (Montibeller and von Winterfeldt, 2015). We proceed to review the main cognitive biases and highlight their role in explaining some CE behaviors. Then we survey the behavioral interventions that target these biases.

### 2.1. Anchoring and reference points

The “anchoring bias” (Tversky and Kahneman, 1974) is the tendency of individuals to take a situation or stimulus as a reference point (“anchor”) and make their choice adjusting from that. An anchor can be set either by a relevant piece of information or by a physical aspect of one’s decisional context (see, e.g., Congiu and Moscati, 2020).

#### Informational anchors and feedback

In the case of waste separation behavior, anchors can be set by information about one’s past behavior and/or goals to be reached (i.e., feedback). For instance, Meineri et al. (2021) show that households that received information on their waste generation rate and the target of the local authorities for this figure significantly reduced the amount of waste they generated compared to a control group that did

not receive such information. The very recent study by Ishimura et al. (2024), involving 1660 Japanese municipalities, sheds further light on the power of goal setting. The authors show that a policy that sets food waste reduction goals led to a decrease in annual waste generation by approximately 3.38 kg per capita, which is equivalent to an economic gain of \$689 million annually.

Anchors can also be set by information about others’ conduct. When the received information is positive, i.e., the surrounding environment is characterized by good waste sorting, individuals are more willing to participate in the waste collection (Zhang et al., 2017). In contrast, individuals lose the motivation to actively engage in waste separation when the information is negative, fostering the individual’s belief that waste separation is meaningless or unattainable (Hou et al., 2020).

Education and experience exchange may serve as anchors to stimulate the adoption of CE practices. For instance, it has been shown that families with children are more likely to engage in separate waste collection when children are educated about recycling activities at schools and kindergarten (Knickmeyer, 2020; Varotto and Spagnoli, 2017).<sup>7</sup> Maddox et al. (2011) explore the role of a school-based waste education program to encourage waste sorting at home. Using an educational project (“Take Home Action on Waste”) piloted in Rotherham, in South Yorkshire, the authors find that the intergenerational transmission of waste education led to an increase in recycling rates (8.6% on average) and a reduction in the amount of residual waste (−4.5% on average) of local areas. Similarly, in two experimental studies conducted in Sweden, Ek et al. (2024) test the impact of an Environmental Education Program to improve students’ recycling knowledge. Differently from Maddox et al. (2011), they do not find any effect on the weight of residual waste and food waste in the treated households compared to the untreated ones.

#### Physical anchors

The effect of “physical anchors” is evident in the case of food waste. Several studies show that people base the amount of food they consume on the size of plates or cups (e.g., Kallbekken and Sælen, 2013; Wansink and van Ittersum, 2013). Specifically, larger containers appear to increase food intake, not only because they can contain more food, but because people use the dimension of the container as a reference to judge the quantity of their intake, and, in larger containers, the same quantity appears lower than in small containers. This bias may lead to increased food waste. If consumers underestimate the quantity of food on a plate, they can fill it with a higher quantity than the amount that would satiate them, thus generating leftovers. In an observational study, Wansink and van Ittersum (2013) show that, when faced with the option of selecting plates of different sizes (26.5 vs. 21 cm in diameter), the diners who selected the larger plate served themselves, ate, and wasted (52%, 45%, and 135% respectively) more total food than those with smaller plates.

Clearly, these findings suggest a straightforward nudge to reduce food waste: a reduction in plate size. In effect, there is a rich literature on nudges acting on physical anchors to affect food-related decisions (e.g., Kallbekken and Sælen, 2013; Petit et al., 2018; see also the systematic review of Lindstrom et al., 2023, and the meta-analysis by Zhang et al., 2023). To provide an example, Kallbekken and Sælen (2013), in a field experiment run in 52 hotels from a hotel chain, tested the impact of reducing the plate size (from 24 to 21 cm), finding a food waste reduction by 19.5% in treated hotels with respect to those in the control group.

<sup>6</sup> Singh and Giacosa (2019) explicitly clarify that the biases discussed in their review should be considered illustrative and that they have been included based on sufficient empirical evidence and on suggestions provided by different theories and research streams. Their framework does not exclude the possibility that other additional biases could be included in the conceptualization.

<sup>7</sup> We thank an anonymous reviewer for suggesting that children’s education may work as an anchor for parent’s recycling behavior. Indeed, school programs implying the need to weigh waste at home may provide a quantification of one’s current waste production and act as a starting point for improving recycling. However, we cannot rule out the possibility that this kind of intervention may also increase the salience of waste misbehavior and thus counteract an issue of parent’s inattention.

## Decoys

Anchors can also be set by designing certain options so that they can serve as a reference when evaluating alternatives. The most prominent form of such options is the “decoy”. A decoy is an option in the choice set that is inferior in at least one feature to another option (typically named “target”) and whose purpose is to increase the attractiveness of the target option. Experimental results typically confirm that the target option is more likely to be chosen when a decoy is present (e.g., [Kivetz et al., 2004](#); [Ariely, 2009](#)).

[Stefansdotter et al. \(2016\)](#) provide an example of decoys designed to increase the choice of leased or refurbished smartphones among young people (aged 19 to 28). In their survey experiment, the authors present respondents with a set of choices that contain a new smartphone and two or more “green” smartphones that were refurbished or available for lease, depending on the treatment. In each choice set, one of the two green smartphones was older and had a slightly higher price than the other, thus serving as a decoy. The authors show that adding the decoy increased the selection rate of leased smartphones from 38% to 62%. Interestingly, when the decoy involved a refurbished smartphone, it did not work as intended: the selection rate for these products was reduced to 48% compared to 52% recorded in the control without the decoy, but the difference is not statistically significant. The result may be driven by the potential crowding out of economic incentives on environmental considerations. However, the authors suggest being cautious in interpreting the results, as the study was conducted in a simulated setting and not in a real purchase situation.

## 2.2. Loss aversion and endowment effect

“Loss aversion” ([Kahneman and Tversky, 1979](#)) refers to the tendency to suffer from a loss more than one rejoices from a gain of the same magnitude. Fundamentally, loss aversion implies that decision-makers will strive more to avoid a loss than to pursue a potential gain. A related implication is that decision-makers may experience inertia when considering changing their status quo: even though adopting an alternative would yield a gain, the greater weight placed on potential losses might prevent decision-makers from switching to it ([Samuelson and Zeckhauser, 1988](#)). An example of loss aversion is testified by [Homonoff \(2018\)](#), who compares the impact of a tax on the use of a disposable bag with that of a bonus for a reusable bag of the same amount (\$0.05). The empirical analysis took advantage of the introduction of a plastic bag tax in Washington, DC, and is based on the observed shopping behavior of more than 16,000 customers in grocery stores. The results show that the tax significantly reduced the proportion of customers using disposable bags (by 42 percentage points), while the bonus had no effect.

The “endowment effect” ([Thaler, 1980](#)) is closely related to loss aversion. It refers to the fact that decision-makers value an asset more when it is part of their endowment than when it has to be acquired. For example, in the market experiment that popularized it ([Kahneman et al., 1990](#)), participants charged a higher price to part from the mug they owned than the price they were willing to pay to acquire it when they did not own it. Thus, similarly to loss aversion, it involves an asymmetry between losing and gaining an asset.

Loss aversion and the endowment effect could explain the preference of consumers for new products over second-hand or refurbished ones. As argued, decision-makers may suffer from inertia when faced with the possibility of switching to an option they are not currently adopting, such as buying a second-hand product over a new one, because they respond more intensely to losses than potential gains. Since the status quo of a typical consumer is buying new products, consumers may prefer to maintain their status quo instead of switching to a second-hand product and eventually experiencing a loss because, for instance, the product is defective or performs less than expected.

The endowment effect in the second-hand market for defective and non-defective products has been investigated by [Botchway et al. \(2023\)](#).

The authors conducted an online survey experiment in which 422 participants were randomly assigned the role of buyer or seller and presented with products that were not defective, defective with a repair paid by the buyer or defective with a repair paid by the seller. Results confirm a significant endowment effect for non-defective and defective products when repair is available, in that sellers stated a higher evaluation for the product than buyers. However, the endowment effect disappears for defective goods without repair. This suggests that in the case of defective products, only the availability of repair increases the seller's evaluation of them and hence drives the endowment effect, as buyers instead raise their evaluations only slightly.

Relatedly, loss aversion and the endowment effect can also account for the evidence that consumers tend to stockpile their old mobile phones at home instead of taking them to recycling facilities ([Ylä-Mella et al., 2015](#); [Echegaray and Hansstein, 2017](#); [Wilson et al., 2017](#)). Some of the recurring motivations found in the literature are that consumers feel that their used mobile phone is valuable because it is part of their endowment, and parting from it is perceived as a loss.<sup>8</sup>

## Defaults

Loss aversion can be harnessed by setting defaults. A “default” is an option automatically enforced on the decision-maker unless she actively chooses otherwise ([Johnson and Goldstein, 2003](#)). Examples of defaults are automatic enrollment in saving plans ([Thaler and Benartzi, 2004](#)) or energy plans based on renewable resources ([Ghesla et al., 2020](#)). In these cases, people tend to comply with the default because they perceive it as a recommendation set in their best interest, over-value potential losses from noncompliance, and experience decisional inertia (see above).

Defaults are widely used to reduce waste generation (e.g., [Ebeling and Lotz, 2015](#); [Mundt et al., 2020](#); [Giaccherini et al., 2021](#)). As a real-world application, consider the change of default consent in the reception of unaddressed mail, introduced by the municipality of Amsterdam in January 2018. Before the change, citizens were assumed to consent to receiving unaddressed correspondence by default. In contrast, the new default requires citizens to explicitly consent by attaching a sticker to their mailbox. The default change led to a reduction in paper waste from 1.85 kg per person to 1.60 kg, leading to an overall reduction of around 17%–20%, equated to savings of €500,000 in administrative costs ([Endendijk and Botzen, 2023](#)).

The experiment by [Mundt et al. \(2020\)](#) tests a change of default in the provision of plastic straws in beverage cups in cafeterias. Specifically, half of the cups already had a plastic straw in the control condition, whereas the remainder did not. In the treatment, all cups were provided without straws, but they could be picked up from a coverless box placed near them, implying that they were still available in the decision-maker choice set. The results show a statistically significant reduction in straw consumption between treatment (60%) and control (30%).

## Framing

“Framing” ([Tversky and Kahneman, 1981](#)) refers to how a choice situation is presented (or “framed”) to the decision-maker, including its contextualization (e.g., investment vs. donation) and the aspects that are emphasized (e.g., benefits vs. harms). To be considered as framing, how a choice scenario is presented must emphasize certain aspects of the situation without altering the substance of the options, that is, the outcomes and their probabilities (if any). In other words, alternative framings involve logically equivalent presentations of the same choice scenario.

<sup>8</sup> Other recurrent reasons for stockpiling phones relate to emotional attachment and guilt associated with their disposal; nonetheless, these are motivational biases and will be discussed in Section 3.3.



The archetypical example of framing involves emphasizing losses or downsides in place of gains or upsides, thereby leveraging loss aversion (Tversky and Kahneman, 1981; for a review of its applications in pro-environmental behavior, see Homar and Cvelbar, 2021). The experiment by Nelson et al. (2021) illustrates loss framing for messages addressing marine pollution caused by plastic waste. Specifically, the experimenters displayed a sign on the counter of a convenience store in Indonesia, framed in positive or negative terms, and tracked the number of plastic bags demanded by consumers ( $N = 721$ ). The positively framed message read: “Do you really need a plastic bag? Refuse it and you will save the ocean!”, whereas the negatively framed counterpart stated: “Do you really need a plastic bag? Refuse it or you will destroy the ocean!”. Contrary to expectations, although the differences are not statistically significant, the positively worded message elicited the highest rate of plastic bag avoidance (50%) compared to the negatively worded one (45%). However, both signs significantly raised plastic bag avoidance with respect to the control with no sign (30%).

Another example of framing is related to waste prevention by choosing to refill exhausted containers for liquids rather than buying them anew (Bashir et al., 2020). In a survey experiment, a group of respondents was presented with a message emphasizing the safety aspects of various refill solutions; a second group with a message emphasizing environmental benefits; a third group with a message emphasizing both aspects; and a fourth group acted as a control and received plain information about cleaning. Results show that a framing that jointly emphasizes safety and environmental benefits increased the stated intention to adopt refill behaviors, measured on a scale from 1 to 7, by 0.64 units on average. In contrast, the framings that emphasized either benefit individually proved ineffective.

### 2.3. Certainty effect, disappointment, and regret

The “certainty effect” refers to the tendency of the decision maker to overvalue the outcomes considered certain compared to those that are merely probable (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981; Cohen and Jaffray, 1988). Specifically, individuals tend to exhibit risk aversion with respect to sure outcomes but become considerably less risk averse as probabilities move away from certainty.

There are several explanations for this phenomenon. First, decision-makers subjectively distort probabilities (Prelec, 1998) and are highly sensitive to changes in probability at the boundaries of the probability space (i.e., 0 and 1) than in any other point (e.g., 0.6). Second, decision-makers may be averse to disappointment and regret (Feldman and Ferraro, 2024). According to this explanation, decision-makers tend to select sure options because they anticipate the disappointment they would feel if the risky option led to an unfavorable outcome rather than a favorable one (Bell, 1985; Gul, 1991) and anticipate the regret of not having chosen the sure option (Loomes and Sugden, 1982; Zeelenberg, 1999).

The certainty effect may account for several concerns that consumers generally report in relation to second-hand consumption, specifically those about the product’s quality, safety, and hygiene of the product. Quality concerns relate to the fact that second-hand products may have unobservable defects that adversely affect their performance (e.g., Fernando et al., 2018). For instance, the adoption of refurbished mobile phones is hindered by concerns about the phone having lower functionalities or unexpected contingencies that force the consumer to lose time to repair or replace the product (van Weelden et al., 2019; Wilson et al., 2017). Such concerns can be linked to a certainty effect. In comparing new and second-hand products, consumers may contrast the risks of defects or malfunctions posed by second-hand products with their absence in the case of new products. Since consumers overvalue certainty, they may be more prone to opt for the more expensive but safer option (the new product) over the risky but cheaper second-hand option. In addition, consumers may be reluctant to purchase a second-hand product because they anticipate their disappointment and regret if

they end up dissatisfied with its performance (e.g., Mugge et al., 2017; Kurniawati, 2019).

The certainty effect can also explain the safety and hygiene concerns for certain categories of products, such as second-hand clothing and furniture (Yan et al., 2015; Edbring et al., 2016; Hur, 2020; Silva et al., 2021; Colasante and D’Adamo, 2021). Specifically, consumers often fear “contamination” if they touch clothing and furniture previously owned by others (Yan et al., 2015; Ackerman and Hu, 2017) without considering that sanitizing procedures eliminate health risks equally for both new and second-hand products. This suggests that consumers might overestimate the probability of harm associated with the adoption of second-hand goods because they contrast it with the perceived safety of new goods and prefer the latter option.

Even though the certainty effect, disappointment, and regret are relevant biases in second-hand consumption, the literature lacks experimental contributions testing behavioral interventions that can correct the misperception of risk for second-hand products.

### 2.4. Habit, limited attention, and forgetfulness

Prior habits may hinder sustainable behavior. Repeated behavior is known to generate patterns that are likely to be exhibited automatically in the future (Aarts et al., 1998; Ouellette and Wood, 1998). The implication of habit for CE is straightforward: consumers are used to linear consumption models, and such habit constrains the substitution of current practices with CE ones (Jayaraman et al., 2011; Parajuly et al., 2020). For example, consumers tend to shop with disposable plastic bags, have coffee in single use cups, or drink a beverage from a straw because they are used to doing so (Jayaraman et al., 2011). Similarly, people tend to ignore logos and recycling information on how to dispose of compostable plastics and adopt the default behavior of discarding them with conventional plastic waste (Ansink et al., 2022). These findings confirm that adopting a contrasting behavior may be effortful once a habit is established, especially considering that habituation tends to involve automatic and unconscious information processing rather than cognitive deliberation (Aarts et al., 1998).

In addition to habit, sustainable behavior can also be constrained by people’s selective attention. Individuals can direct their attention to just a subset of the elements of their decisional context, be they pieces of information or visual cues. Typically, attention is paid to those elements of the choice environment that stand out from the rest for some reason, that is, that are prominent or “salient” (Bordalo et al., 2022). Evidence shows that salient aspects are more likely to capture the decision-maker’s attention and be processed when making a decision, whereas less salient ones might be ignored altogether (for a review, see Bordalo et al., 2022).

The fact that individuals process a limited set of contextual elements and selectively direct their attention to the most salient ones has two important implications. First, salient contextual cues play a role in activating prospective memory, which is the type of memory engaged in performing the actions that have been planned (Einstein and McDaniel, 2005; Smith et al., 2007). Thus, if decision-makers set themselves to adopt the CE behavior but do not find in their choice environment salient cues that activate prospective memory, they may forget to exhibit the behavior when the time comes (Jayaraman et al., 2011; O’Brien and Thondhlana, 2019; Essl et al., 2021). For example, consumers may persevere in using plastic bags when shopping because their environment does not prompt them to adopt reusable bags (O’Brien and Thondhlana, 2019; Gonzalez-Arcos et al., 2021).

Second, as documented by marketing and consumer behavior studies, salience effects may influence consumption choices (Janiszewski et al., 2013; Kim et al., 2019). Specifically, evidence shows that products that are more salient in one’s choice set because they are placed at the beginning of a shelf and/or at eye level in stores are more likely to be selected (Foster et al., 2014; Reijnen et al., 2019). Intuitively, applied to the second-hand market, the salience bias could imply that

the choice of used products may depend on the prominence with which they are displayed relative to that of new products.

In summary, the literature on habit and selective attention suggests that deploying carefully designed cues in the decision-maker's choice environment could break habits, steer consumption patterns, and activate prospective memory for CE practices. Nudges that can do so rely on salience, accessibility, and commitment mechanisms. In the following, we review these three types of behavioral instruments.

#### *Salience nudges*

An example of a salience nudge is the provision of reminders in the form of visual cues. In the field experiment conducted by [Essl et al. \(2021\)](#), reminders are used to stimulate customers of a Swiss agricultural association that delivers food in plastic bags to return them for reuse. Two kinds of reminders were used: a flyer attached to the external food box and a sticker attached directly to the plastic bag in the box. The sticker on the bag worked as an action-close reminder, that is, customers could notice the reminder when deciding whether to reuse or discard the bag, while the flyer on the box worked as an action-distant reminder. The results show that, compared to the control group that received no reminder, the provision of salient reminders increased the reuse of plastic bags by around 80%. However, the probability of reusing a bag marked with the sticker was 58% higher than that of an unmarked bag and 41% higher than that recorded in the flyer treatment, suggesting that the proximity of the reminder to the related action may further reinforce its impact. This is also coherent with the findings of [Egebark and Ekström \(2016\)](#) and [Chakravarty and Mishra \(2019\)](#), who tested the impact of an appeal to paper conservation. In the first case, the appeal, sent by email to university employees and inviting them to limit printing and resort to double-sided printing, had a negligible effect. In the second example, the conservation nudge presented on a poster pasted directly on the printer significantly reduced paper consumption.

Examples of salient cues can also be found for recycling. Some contributions show that differentiating bins by color or attaching stickers to them can increase the frequency of waste sorting (e.g., [Shearer et al., 2017](#); [Zhang and Wang, 2020](#)). For example, in the large field experiment by [Shearer et al. \(2017\)](#), which involved more than 60,000 households in an English county (Surrey), sticker prompts were attached to the garbage bins of the treated households to remind them to use the food waste recycling service. The authors find a significant increase of about 20% in food recycling in treated households compared to households that received no treatment. Even the quality of the separate collection can be improved by visual nudges that increase the salience of recycling instructions. [Lotti et al. \(2023\)](#), in a field experiment run in two buildings on a large university campus, found that showing watching eyes in combination with recycling instructions reduced sorting errors by 7 percentage points compared to showing recycling instructions only. The authors interpret this result as driven by increased attention to instructions, considering that showing only watching eyes without recycling information increased sorting mistakes by 4.5 percentage points.

#### *Accessibility nudges*

The case of the “Drink Local” program, initiated by Princeton University in 2009, provides an example of an accessibility nudge ([Santos and van der Linden, 2016](#)). The program endowed a group of students ( $N = 881$ ) with reusable bottles. Compared to a control that did not receive any ( $N = 421$ ), students endowed with a reusable bottle reported lower frequencies of purchased bottled water, and the differences are statistically significant. For instance, 66.5% of respondents in the treatment group stated they had never bought bottled water since receiving the reusable bottle, while in the control group this share was 57%. Moreover, respondents in the treatment group were also more likely to support a campus-wide ban on bottled water (around 57% vs. 49% in the control). Similarly, in a large field experiment involving

more than 5000 Armenian shoppers, [Antinyan and Corazzini \(2025\)](#) show that the free provision of a reusable bag for shopping reduces demand for plastic bags — recorded at 30% in the control — by around 4 percentage points when paired with a message explaining harms of plastic to the environment and 7 percentage points when paired with a financial bonus.

For the specific case of reuse, [Frick et al. \(2021\)](#) conduct an online experiment (Study 2;  $N = 881$ ) in which they test the effectiveness of an accessibility nudge through a social media campaign to promote the repair of clothing. In one treatment, participants were presented with posts stressing the ease with which jeans can be repaired (“Torn jeans? It's easy to repair them”). In the control, participants received neutral communication (“Jeans – they always fit”). At the end of the experiment, participants were offered the opportunity to enter a raffle to win a €10 coupon to be spent in a second-hand online store or a traditional retail shop; this choice maps the participant's intention to purchase second-hand products in the future. Results show that participants presented with posts promoting jeans repair were 1.5 times more likely to choose the coupon for the second-hand shop.

The survey experiment by [Stefansdotter et al. \(2016\)](#) shows an application of the accessibility effect to the case of second-hand and repaired smartphones. The authors present a sample of young consumers with hypothetical choices between new smartphones. In the treatment, second-hand smartphones were presented alongside the new ones, that is, were actively offered. In the control, used alternatives were not actively offered and could be accessed by clicking on a link located in a separate menu. The authors find that 29% of the respondents opted for the used smartphone when this was actively offered, whereas only 4% did so in the control; the difference is statistically significant. Interestingly, this trend also holds when the used option is substituted by the possibility of repairing one's smartphone: although the majority of respondents opted for the repair option in the control (67%), a larger share (87%) did so when this alternative was more accessible; also this difference is statistically significant.

#### *Commitments*

The adverse effects of habit and forgetfulness can also be addressed through commitment plans. A “commitment” involves a pledge on the part of the decision-maker to carry out a specific behavior. At a basic level, a commitment works because it sets the decision-maker's mind (or “primes” it) towards the action to be exhibited, thus overcoming inattention and habit. Other underlying factors may determine its effectiveness, depending on the type of commitment made. For instance, commitments can be “soft” or “hard”. If a decision-maker subscribes to a soft commitment, she cannot be punished in any way for not honoring the pledge, while in the hard version, individuals can “bet” an amount of money that will be lost in case of failure (e.g., a sum of money to be donated to a charity). Moreover, commitments are either “private” or “public”. A private commitment is made with oneself and targets one's pride or ego; on the contrary, publicly made commitments leverage social mechanisms such as social approval and avoidance of shame. Hence, commitments may also leverage motivational biases, and not only a priming effect.

In any case, commitments have been frequently used to promote waste sorting ([Katzev and Pardini, 1987](#); [Wang and Katzev, 1990](#); [Cobern et al., 1995](#)). In the field experiment by [Alonso-Paulí et al. \(2024\)](#), involving 1500 households in Palma de Mallorca (Spain), randomly selected participants in the treated group were allowed to sign a soft commitment consisting of a pledge to sort bio-waste. Compared to the control group of participants without intervention, the soft commitment increased regular participation in biowaste sorting by around 30%, and the effect persisted over time.

### 3. Motivational biases and nudges

Motivational biases underlie situations in which judgment or behavior deviates from the prescriptions of standard economic theory due to concerns of social and emotional desirability associated with the options and their outcomes (Montibeller and von Winterfeldt, 2015). These biases largely pertain to affective, moral, or social considerations influencing behavior and judgment. We call attention to three broad sources of motivational biases that may be particularly relevant for CE behaviors: conformity to social norms; concerns about self-image and identity; and emotions. In keeping with what was done in Section 2, we also review the nudges that can address these biases.

#### 3.1. Social norms

“Social norms” can be defined as unwritten rules of social conduct. Specifically, social norms refer to how people behave and expect others to behave in social contexts (see, e.g., Cialdini and Trost, 1998; McDonald and Crandall, 2015; Keizer and Schultz, 2018). The literature on social norms distinguishes between “descriptive” norms, which provide a description of how others typically behave (e.g., “my neighbors recycle their waste”); “injunctive”, which refer to conducts that are expected or approved of by others (e.g., “my neighbors expect me to reduce the production of waste”); and “moral”, based on what is perceived to be “right” (e.g., “I must keep the environment clean”). Social norms can also be categorized based on whether they suggest that a certain behavior is exhibited (as in the examples provided above) or avoided (e.g., “I should *not* litter the environment”). The former kind of norm is termed “prescriptive” or “positive”, whereas the latter is termed “proscriptive” or “negative” (on the classification of social norms, see Anderson and Dunning, 2014).

There is consolidated evidence in the literature that social norms drive waste-sorting choices (e.g., Nyborg et al., 2006; Brekke et al., 2010; Thomas and Sharp, 2013; D’Amato et al., 2016; Massarutto et al., 2019). Czajkowski et al. (2017), in a survey administered to a sample of Polish households, find that about 75% of respondents declared that sorting waste was a moral duty and “something everyone should do”. Interestingly, around 25% of respondents stated that they would feel negatively judged if they did not sort waste, and around 50% agreed that they would negatively judge people who do not sort waste, ultimately suggesting the presence of injunctive norms.

Social norms are also relevant in motivating waste reduction (e.g., Abbott et al., 2013; Borg et al., 2020; Salazar et al., 2021). In a survey conducted on Australian respondents, Borg et al. (2020) find that self-reported avoidance of plastic items (bags, straws, coffee cups, and food containers), as well as the intention to avoid their use, correlate positively with perception of the extent to which others avoid plastic items (descriptive norm) and approve of plastic avoidance (injunctive norm). Although evidence on the impact of social norms on repair and reuse practices is still scarce, some studies suggest a potential positive effect. For instance, Parajuly et al. (2023), surveying intention to repair among 992 volunteer repairers in European countries, find injunctive social norms as the main predictors of this practice, but only if carried out at public events. Finally, recent research shows that social norms play a role also in promoting the purchase of more circular products, such as goods and packaging made of recycled plastic (Corsini et al., 2024; Ertz et al., 2023).

Despite the robust evidence in their support, three aspects need to be considered when assessing the influence of social norms. First, whether a social norm promotes or impedes waste-related behavior depends on how the norm is interpreted. For instance, Corrado et al. (2022) show that recycling rates decrease when citizens see their environment as degraded because it conveys a descriptive norm suggesting that most people do not properly sort waste. Similarly, Brekke et al. (2010) warn that the duty orientation to recycle may be eroded by the

perception that others are not recycling and thus do not share the same moral norm.

Second, the impact of social norms varies depending on the type of material and behavior under consideration. For instance, while there is a social norm to recycle one’s domestic waste, such as organic, plastic, and paper, there seems to be the opposite social norm for waste from electrical and electronic equipment (WEEE). We have already noted that the evidence suggests that households generally stockpile electronic equipment or dispose of it improperly. For instance, the survey by Ylä-Mella et al. (2015) reports that 85% of Finnish consumers store their unused mobile phones at home (see also Casey et al., 2019).

Finally, the perception of social norms depends on the degree of visibility of the behavior in question. For instance, solid waste recycling typically has a high degree of visibility since it can be observed “every time someone puts their container at the curbside” (McKenzie-Mohr, 2011, p. 78). By contrast, waste reduction practices, such as buying products with less packaging or adopting refurbished appliances, may be characterized by a lower degree of visibility since it is hardly the case that such decisions are broadcast to others (Barr, 2007; Cecere et al., 2014). Less visible actions may then be driven primarily by other considerations, such as maintaining a positive self-image (see Section 3.2).

#### Conveying social norms through messages

People feel pressure to conform to social norms, whether descriptive, injunctive, or moral. If an individual behaves in a way that is not consistent with a social norm, she can be made aware of the existence of that norm and the conduct it suggests. Typically, awareness about social norms is raised through written messages, for instance by displaying signs in the choice environment. Alternatively, social norms can be conveyed by designing the environment so that the decision-maker can observe others’ behavior, and social norms can be inferred by the context (on the distinction between verbal and nonverbal nudges, see Congiu and Moscati, 2020).

Starting with the former channel, numerous studies have tested the impact of social norm messages on waste sorting and reduction (e.g., Chakravarty and Mishra, 2019; Meineri et al., 2021; Chandra, 2023). For example, in the field experiment conducted by Salazar et al. (2021) in a marine park in South Portugal, signs were displayed at a concession stand cashier, close to a paper straw dispenser, to reduce the demand for straws when buying a beverage. Results show that the straw-to-cup ratio was the lowest (0.111) when it was displayed the sign conveying a positive injunctive norm (“Choose to drink directly from the cap or can. The planet thanks you!”) compared to the 0.172 registered in the control. Similarly, Loschelder et al. (2019) find that consumption of disposable to-go cups for hot beverages can be significantly decreased by conveying a “dynamic” descriptive norm, which refers to how one’s peers’ behavior changes over time. In their field experiment conducted at a university cafeteria, the authors affixed a sign informing customers, “Our guests are changing their behavior: More and more are switching from the to-go-cup to a sustainable alternative [i.e., a reusable mug]”. The sign reduced consumption of disposable to-go cups for beverages by 17% on average over the intervention period, from 27.8% to 23.7% of the baseline with no sign.

Normative feedback stimulating social comparisons has been proven to be effective in improving waste sorting, both with respect to increasing diversion rates (e.g., Schultz, 1999; Nomura et al., 2011; Mertens and Schultz, 2021) and improving the quality of the separate collection (Timlett and Williams, 2008; Dupré and Meineri, 2016). In a large-scale field experiment involving two Swedish municipalities, Ek and Söderberg (2024) evaluate the impact of different types of feedback on the amount of households’ residual waste. In a treatment group, households received static information on the average amount of waste produced by the household itself, by a reference group of households, and by a subset of efficient neighbors, i.e., in the bottom 20 percentiles of the waste weight distribution. In another treatment, households



received dynamic feedback, i.e., informing how waste behavior had changed since receiving the last letter. Both types of feedback induced significant waste reduction (7%–12%), which persisted after the end of the intervention.

#### *Conveying social norms by increasing action visibility*

The second channel to convey social norms involves designing the context so that social norms and behavioral deviations from them are made visible to everyone involved. In fact, when behavior is observable, people are induced to follow social norms because image concerns and considerations of social approval matter (Zafar, 2011; Anderson and Dunning, 2014). An example is provided by the framed field experiment by Alpizar and Gsottbauer (2015), where participants were asked to play a threshold public goods game. In the game, they received an initial endowment, representing units of time and effort, and were asked to choose how much of the endowment to dedicate to recycling. The public good (waste separation by the municipality) was obtained only if the total effort devoted by the group exceeded a given threshold. In one treatment, participants who contributed below the individual optimal threshold were given red flags that publicly exposed their free riding to the other participants, thus leveraging social disapproval and embarrassment; in another treatment, participants who contributed above the individual optimal threshold were assigned green flags, leveraging social approval and pride. Both mechanisms were effective in raising contributions: with respect to the average individual contribution recorded in the control (1.86), the green flag increased individual contribution by 21% (2.25) and the red flag by 39% (2.58). These findings suggest that visual cues can act as public feedback mechanisms that expose one's deviation from a norm and that people are more sensitive to social disapproval than approval.

A similar idea underlies the “Clear Bag Policy” introduced in a medium-sized city in Canada in 2015, whose effects have been studied by Akbulut-Yuksel and Boulatoff (2021). Under this policy, households were mandated to adopt transparent bags for all waste destined for landfills instead of traditional black bags (still, one dark bag per household was allowed for waste that posed privacy concerns). Transparent bags make it clear to everyone in the neighborhood whether a household does not properly sort its waste, exposing it to potential social disapproval. In effect, the analysis by Akbulut-Yuksel and Boulatoff (2021) shows that clear bags increased recycling by 15%. Besides, the intervention increased the rate of donations of clothing and small appliances to local charities, likely because households could not dispose of such products in their bags. This suggests that policies of this kind could have positive spillover effects for reuse, although further research is needed to draw definitive conclusions about such effects.

The finding that the visibility of individual actions is relevant to encouraging sorting behaviors is also confirmed by Bucciol et al. (2019), using administrative data on unsorted waste bin emptying at the household level in the province of Treviso (Italy). In this context, the waste tariff (Pay-As-You-Throw) paid by each household is based on the amount of unsorted waste produced, but the waste bins may be assigned to one, two, or more households for logistical reasons. The authors show that when two households share the bin, the production of unsorted waste is significantly lower (around –23%) than when the bin is associated with only one household. Interestingly, when more than two households share the same bin, the waste production is not statistically different from that with single-bin households. These findings can be explained by the different degrees of visibility of the sorting behavior under these alternative bin-sharing policies. When two households share the bin, discarding unsorted waste becomes a visible action that may stimulate feelings of shame. When more households share the same bin, peer monitoring becomes more difficult, and no shame arises from misconduct.

In previous examples, the visibility of individual actions stimulates appropriate waste behaviors, reinforcing the existing social norm through the desire not to be sanctioned by others or receive social

approval. However, visibility may convey the social norm through the good example provided by others' behaviors. Babutsidze and Chai (2018) show that when peers' actions are visible, other agents are more likely to adopt green behaviors. In contrast, when actions adopted by neighbors are not visible, there is no significant effect on the propensity to adopt both visible and non-visible green actions by other people. Interventions based on “social modeling” exploit this leverage. Some studies recruit community members to act as “block leaders”, i.e. to display their sorting behavior and convince other members to follow their lead. Xu et al. (2016), for instance, show that the presence of volunteers at bins stations supporting the recycling activity of other residents through demonstration and explanation was a key factor in increasing food waste capture rates. In the same spirit, Burn (1991), Hopper and Nielsen (1991) and Lin et al. (2016) all confirm that using block leaders is an effective way to increase recycling participation rates, even more effective than providing only information (Varotto and Spagnolli, 2017).

In the case of repair and reuse, social media appears to be an interesting avenue for exploiting the influence of social norms conveyed through visible behaviors. The study by Frick et al. (2021), mentioned above, also tests the impact of peer endorsement for posts suggesting jeans repair on the participant's intention to favor second-hand products. However, the study finds no statistically significant effects of peer endorsement, and thus injunctive social norms, on intention to repair.

Ultimately, these contributions suggest that showing what other people do or approve of can lead individuals to conform to social norms without the need to convey them verbally. However, it also draws attention to the importance of carefully designing decisional contexts to broadcast virtuous behavior to others. Brück et al. (2017) warn about the potential side effects arising from the interaction between individual identity and behavior visibility, arguing that individuals against environmentalism may reduce their pro-environmental actions when their behavior is visible.

#### *3.2. Self-concept, self-image, and identity*

Another source of motivational biases pertains to how one perceives and conceptualizes oneself, that is, one's “self-concept” (Bailey, 2003). As the psychological literature suggests, the self-concept encompasses a variety of constructs, notably self-image and identity (see, e.g., Oyserman et al., 2012).

“Self-image” can be defined as the mental picture depicting how one perceives oneself. More specifically, self-image includes “(measurable) concretes about what one does (e.g., achieving work products, like sports records), measurable aspects of how one appears (e.g., one's body proportions) and material things one has” (Bailey, 2003, p. 385).

“Identity” refers to who the individual is in terms of the groups to which she belongs. It can be defined as “those aspects of a person's self-concept based upon their group memberships together with their emotional, evaluative, and other psychological correlates” (Turner and Oakes, 1986, p. 240). Clearly, an individual may belong to several different social groups and thus may have diverse identities. The impact of one's identity in a given choice context depends on how strongly one identifies with a group and how relevant the identity is in that context. It also depends on whether the identity is subjected to stigma, that is, socially devalued by being associated with negative beliefs and stereotypes (Crocker et al., 1998).

How one conceives of, perceives, and identifies oneself may drive one's decision to engage in CE behaviors. For instance, several studies show that maintaining a positive self-image and having a “green” identity prove important determinants of recycling behavior (e.g., Brekke et al., 2003; Mannetti et al., 2004; Binder and Blankenberg, 2017). The rationale is that an individual forms an idea of the person she wants to be, such as a socially or environmentally responsible citizen, and carries out a behavior she deems representative of such idea, in this case, recycling.



Similarly, self-image and identity become relevant for repair and reuse, especially for clothing. It is believed that clothing contributes to constructing and broadcasting one's identity and is a way to signal one's social status, gender, and age (Armstrong et al., 2015; Hur, 2020). In effect, numerous surveys indicate that consumers are reluctant to purchase second-hand clothing due to concerns about embarrassment, potential identification with people of low socioeconomic status, and related stigma (Laitala and Klepp, 2018; Lo et al., 2019; Silva et al., 2021). Potential stigma can also impede repair practices because damaged and repaired products may be associated with economic hardship (Terzioğlu, 2021).

In other cases, adopting second-hand or refurbished products may strengthen one's identity and self-concept. For instance, Mugge et al. (2017) provide evidence that certain types of consumers may conceive of their refurbished smartphones as a means to express themselves and communicate their environmental consciousness to their peers. Similarly, Terzioğlu (2021) finds evidence that individuals can experience pride and social approval when they repair their damaged products.

As already discussed in the case of social norms, there is reason to believe that action visibility may affect the relevance of self-image and identity concerns for repair and reuse. Adopting second-hand clothing or electronic devices such as smartphones is a visible behavior, and, for these products, identity concerns might thus become particularly relevant. By contrast, purchasing second-hand appliances or furniture is a less visible action, since such goods typically remain in the privacy of one's dwelling, and their adoption might be thus more related to considerations about one's self-image. However, how the different visibility of CE actions may impact actual behaviors and how behavioral interventions can leverage visibility remains an underexplored issue worthy of further investigation.

#### *Nudges addressing image and identity concerns*

To date we know of only one experiment that tests the impact of leveraging self-image and identity to promote pro-environmental behaviors—the one by Gosnell (2018). By partnering with a renewable energy supplier in the UK serving more than 38,000 customers, the author tests whether an email promoting the adoption of paperless billing would be more effective when it addressed the recipient as “an environmental steward” for being a customer of a sustainable company. At its core, the message works as it urges the customer to behave consistently with the image and identity of an “environmental steward”, and thus avoid paper billing. Besides, it leverages “cognitive dissonance”, that is, the discomfort caused by finding oneself adopting a behavior that is inconsistent with one's preexisting beliefs and attitudes (Festinger, 1957). The author finds that, compared to the control condition, the treatment wording increases the adoption of paperless billing by 1.2 percentage points per week. Interestingly, the intervention backfires among a subgroup of highly educated customers, for whom the wording decreases the adoption rate of paperless billing by 6.2 percentage points with respect to the control.

For those pro-environmental behaviors that are subjected to potential stigma, such as the adoption of second-hand clothing, the nudge literature does not report specific interventions to overcome the related image and identity concerns. Nonetheless, defaults and social-norm messages can still address these motivational biases. More specifically, image and identity concerns for sustainable behaviors can be ameliorated by setting such behaviors as defaults and highlighting the existence of social norms pointing to their appropriateness.

An example of such interventions is offered by the study of Giaccherini et al. (2021), which focuses on increasing the request for doggy bags in restaurants. Diners tend not to ask for a doggy bag because they fear it may signal an unfortunate financial situation, even though doing so contributes to reducing food waste. The authors run a field experiment involving 14 restaurants and 23,600 customers in Italy, in which they test a default change and a dynamic social norm related to the request for doggy bags. In one treatment, diners were informed

that they would be automatically provided with a doggy bag at the end of their meal unless they actively refused. In another treatment, diners were informed that an increasing number of customers were asking waiters for a doggy bag in case of leftovers. Both nudges were communicated through messages displayed via table tents. Compared to a control condition with no intervention, exposure to the dynamic social norm doubled the number of doggy bags requested on average by diners (from 0.5 to 1 per day). By contrast, providing the doggy bag by default did not raise the number of doggy bags requested but increased the likelihood that a diner consumed her entire meal (of 2.7%). This finding can be explained by assuming that diners interpreted the default as conveying information about the desirability of avoiding wasting food rather than asking for a doggy bag, thus favoring the former action.

#### *3.3. Affects and emotions*

Finally, decisions can also be driven by how the decision-maker “feels” about the choice situation. More specifically, an individual is more likely to choose an option if she feels more positive emotions about it, and less likely if she feels more negative emotions (e.g., Mellers et al., 1999; Bagozzi et al., 2016). Moreover, emotions may be instrumental in deciding in situations where the problem is too cognitively demanding to be based on a precise calculation of costs and benefits. This is the idea underlying the “affect heuristic” (Slovic et al., 2007), according to which we choose an option just because we “feel good” about it or we “like” it (Zajonc, 1980), irrespective of many other factors that might be relevant for the decision.

Empirical research shows that emotions influence decisions to engage in a wide range of pro-social and pro-environmental actions (van der Schalk et al., 2012; Bissing-Olson et al., 2016), including waste-related behaviors. Anticipated guilt, for instance, appears to influence recycling behavior, mediating the relationship between individual environmental concerns and the intention to recycle (Elgaied, 2012). Emotions are also relevant drivers behind food waste intentions and behaviors. Negative emotions arising from the guilt of wasting food can motivate individuals to avoid food waste (Graham-Rowe et al., 2014; Carrus et al., 2008), even though stated intentions may not always translate into the corresponding behaviors (Russell et al., 2017).

Positive emotions connected with the ownership of a product may explain why people are often reluctant to dispose of it. This is particularly evident in the case of used smartphones (Wilson et al., 2017). In fact, the literature indicates that people may develop a particularly strong attachment to their smartphone because it is linked to the owner's personal history and memories (e.g., Sohn et al., 2022). Accordingly, they prefer to conserve them at home rather than recycle them, reducing the possibility of recovering and reusing the rare and valuable resources they contain.

#### *Nudges evoking emotions*

Several studies have tested the impact of emotional involvement in various environmental domains and behaviors (Chakravarty and Mishra, 2019; Truelove and Nugent, 2020; Wensing et al., 2020; Chatterjee and Barbhuiya, 2021; Luo et al., 2022). Generally, these contributions elicit involvement through exposure to vivid pictures or videos.

For instance, in an experiment conducted in an office building of a Canadian company, Luo et al. (2022) show that adding a picture of a marine animal trapped in plastic debris on top of informational signs about waste sorting significantly reduces plastic waste (by 17%). Similarly, in the study by Chatterjee and Barbhuiya (2021), respondents presented with a picture depicting a forest littered with plastic, aimed at eliciting a negative emotion towards plastic pollution, declared a higher willingness to pay for an environmental tax on bottled water than participants presented with a neutral picture.

Septianto et al. (2020) evaluate the effect of stimulating a positive emotion towards food waste reduction through a gratitude appeal. Specifically, in their online survey, the authors administer two messages conveying either gratitude for having food (“be grateful you have food on your table”) or gratitude for not starving (“be grateful you don’t go hungry”). Moreover, their implications were conveyed in a loss (gain) frame, highlighting increased (decreased) environmental damage. Results show that the stated intention to reduce food waste increases significantly with a message eliciting gratitude for having food paired with an emphasis on the decrease in environmental damage and with a message eliciting gratitude for not starving paired with an emphasis on the increase in environmental damage. Both gratitude-eliciting messages proved also more effective than a control with no emotional appeal.

Ultimately, this literature shows that eliciting strong emotions can be a promising intervention to foster circular behaviors.

#### 4. Discussion and concluding remarks

In this work, we have reviewed the main cognitive and motivational biases behind individual behaviors relevant to the CE transition, specifically waste reduction, reuse and repair, and recycling, as well as the behavioral interventions that have been tested to address these biases. A summary of these biases and related nudges is provided in Table 1.

Our objective was to provide a link between the most common barriers to CE practices and the main decisional biases documented in the behavioral economics literature. The fact that these barriers may be linked to well-known biases offers interesting avenues for research. First, it allows researchers to bring into the analysis of the factors underlying CE practices the huge body of literature on decisional biases, specifically on their nature and characteristics, thus broadening our understanding of the barriers to CE behaviors. Second, policymakers and experimenters may make instrumental use of the knowledge on decisional biases, and especially the techniques that are known to ameliorate the impact of biases on decision-making, to design and test interventions that can overcome barriers to CE behaviors. For instance, recognizing that loss aversion may hinder the adoption of secondhand devices allows one to refer to relevant meta-analyses (e.g., Brown et al., 2024) as well as the experiments that have tested mechanisms to ameliorate it, such as debiasing through experience (e.g., Hueber and Schwaiger, 2022). In terms of policymaking, this would suggest an intervention based on a trial period or similar programs that aim to make customers more experienced with second-hand products.

Further, in adopting the taxonomy “cognitive–motivational”, our article contributes to the literature on another important front, that is, it takes into account whether a barrier to a CE behavior has a cognitive origin (e.g., refers to a judgment error) or a motivational one (e.g., has to do with one’s image or desire to conform to peers). As the literature review has shown, this distinction illuminates a first point of separation between the various CE practices. For instance, it seems that waste recycling is related more heavily to motivational biases, specifically norm conformity and image concerns, than cognitive biases. On the other hand, some behaviors, such as waste reduction and reuse/repair, appear to be affected by both cognitive and motivational biases. For instance, second-hand consumption is affected by loss aversion, disappointment, and regret but also by conformity to social norms and by image and identity concerns.

Understanding which of the two categories of biases is more relevant for a specific behavior helps design the appropriate intervention. For instance, if the barrier to the adoption of refurbished electronic devices is represented by the overestimation of malfunction risks, this choice will hardly be stimulated by interventions aimed at leveraging one’s environmental consciousness. Likewise, adopting products or behaviors plagued by stigma and other social concerns may not benefit adequately from interventions correcting the misperception of risks. Ultimately, we feel that distinguishing between cognitive and

motivational biases is useful as it may prompt future research to investigate whether, for a given CE behavior, cognitive biases are stronger determinants than motivational ones or vice versa and in what circumstances and social contexts this occurs.

Indeed, our review highlights that there can be a multiplicity of biases that can hinder each of the diverse CE behaviors, and identifying which bias is more relevant has to be studied in the specific social context. This, in turn, implies that it is difficult to draw general conclusions on the most successful nudges to stimulate appropriate behaviors and that it is crucial to assess their impact on a case-by-case basis. The beneficial effects of these interventions are not equal in all contexts, and thus, they cannot be considered universally applicable. This is confirmed when we look at the apparently contrasting conclusions reached by previous reviews. For instance, the desire to adhere to social norms has been found to be relevant in driving visible behaviors like waste sorting, and, accordingly, interventions that convey social norms can successfully increase recycling rates. Indeed, Varotto and Spagnoli (2017), in their meta-analysis of 36 studies with 70 interventions to promote household recycling, find that strategies based on social modeling (block leaders) are the most effective. However, the survey by Knickmeyer (2020) suggests instead that interventions based on social comparisons can fail to support the motivation for recycling in rapidly changing urban areas, characterized by the lack of sorting visibility and a low sense of community.

In the same line, the meta-analysis by Zhang et al. (2023), comprising 22 articles with a total of 35 interventions to encourage food waste reduction, shows that policies based on smaller servings/plate size are more successful than those based on salient prompts and information. Nonetheless, the authors also point out that the effectiveness of the specific nudge depends on individual and setting characteristics: for instance, it appears that nudges applied in public settings, such as hotels, canteens, and cafeterias, are more effective than those in private ones (e.g., at home).

Applying nudges to the appropriate context is crucial as they may otherwise fail to achieve their intended effects and can even have adverse consequences (the so-called “boomerang effect”). For instance, in a deteriorated environment where citizens are not actively engaged in proper waste sorting, and/or where the collection system is inefficient, an intervention emphasizing a descriptive social norm could potentially worsen the existing negative behavior and impede the adoption of the desired behavior. Similarly, interventions based on stimulating conformity with the prevailing social norm may have adverse effects, discouraging the adoption of sustainable practices, like wearing second-hand clothes in contexts where it is not a common habit.

Our review has also shown that behavioral interventions should be tailored to the specific waste behavior, and strategies that prove effective in addressing a particular behavior may not necessarily be successful in influencing others. This suggests the need to conduct further research, especially for those practices that are still widely underexplored, such as reuse and repair.

Another overlooked area of research is related to the potentially heterogeneous impact of behavioral interventions across different social groups. The use of second-hand items is illustrative in this respect. Fostering the consumption of second-hand products, for example, through nudges that promote one’s image as an environmentally friendly person, may be effective for wealthier people, but may be less impactful for lower-income people to the extent that they perceive the possession of new goods as a signal to enhance their social image.

In conclusion, there is a gap in the literature on biases that can explain why people do not engage in circular practices. As highlighted in some previous reviews, only a few of the studies that test the impact of behavioral interventions are based on a pre-trial analysis of the context and the bias affecting people involved in the intervention (Varotto and Spagnoli, 2017; Trushna et al., 2024). However, as we argue in this article, exploring the bias affecting individual behaviors is a crucial

**Table 1**  
Summary of biases and nudges illustrated in the paper.

Biases	Interventions	Some illustrations
Anchoring	Informational anchors and feedback	Providing information about past recycling and the level/goal to be reached (Meineri et al., 2021; Ishimura et al., 2024). Providing information about neighbors' conduct (Zhang et al., 2017).
	Physical anchors	Educational campaigns and projects at school may serve as anchors for parents' recycling behavior (Maddox et al., 2011; Ek et al., 2024). Reducing size of plates/cups in buffets and cafeterias (Kallbekken and Sælen, 2013; Wansink and van Ittersum, 2013).
	Decoys	Adding inferior, green smartphones to choice sets (Stefansdotter et al., 2016).
Loss aversion and endowment effect	Small tax on plastic	Five-cent tax on disposable bags (Homonoff, 2018).
	Change of default	Change of default consent to unaddressed email (Endendijk and Botzen, 2023).
	Selectively framing attributes (losses, benefits)	Messages framing outcomes in negative vs positive terms, such as “Refuse the bag and you will save the ocean” vs. “Refuse the bag or you will destroy the ocean” (Nelson et al., 2021). Framing benefits highlighting safety vs sustainability (Bashir et al., 2020). Change of default provision of plastic straw (Mundt et al., 2020).
Habit, limited attention and forgetfulness	Salience nudges	Salient flyers or stickers to remind one to reuse bags (Essl et al., 2021). Appeal for paper conservation written on a poster attached above printers (Chakravarty and Mishra, 2019) or sent via email (Egebark and Ekström, 2016). Making recycling bins more salient through different color or stickers (Shearer et al., 2017; Zhang and Wang, 2020). Pictures of watching eyes with recycling instructions (Lotti et al., 2023).
	Availability nudges	“Drink local” program, involving the free provision of reusable bottles (Santos and van der Linden, 2016). Free provision of reusable bags in stores (Antinyan and Corazzini, 2025). Conveying ease of access to jeans repair (Frick et al., 2021). Actively offer green options (smartphones) on the same webpage rather than displaying them on a separate one (Stefansdotter et al., 2016).
	Commitment and pledges	Soft commitments to engage in proper recycling (Alonso-Paulí et al., 2024).
Social norms	Normative messages	Messages based on social norms to reduce demand for plastic straws (Salazar et al., 2021). Dynamic-norm messages to foster demand for reusable caps/mugs (Loschelder et al., 2019). (Dynamic norm) feedback provision on recycled waste (Ek et al., 2024).
	Action visibility	Red and green flags to signal cooperators vs free riders (Alpizar and Gsottbauer, 2015). Clear bag policy (Akbulut-Yuksel and Boulatoff, 2021). Shared recycling bins (Buccioli et al., 2019). Showcasing peer endorsement of posts (Frick et al., 2021).
	Self-image and identity concerns	Addressing customers as “environmental stewards” to stimulate adoption of paperless billing (Gosnell, 2018). Default provision of doggy bags in restaurants and dynamic social norm to encourage their adoption (Giaccherini et al., 2021).
Affects and emotions	Involvement, guilt	Showing pictures of animals trapped in debris (Luo et al., 2022). Showing picture of littered forest vs neutral picture (Chatterjee and Barbhuiya, 2021).
	Gratitude	Messages leveraging gratitude for having food vs gratitude for not starving (Septianto et al., 2020).

aspect that may influence the effectiveness of the adopted strategy. By advancing a conceptual link between the barriers to CE behaviors and well-known decisional biases, we have laid some groundwork for experimental investigation into the influence of specific biases and interventions on these practices. We hope that our review may assist interested researchers in this endeavor.

#### CRediT authorship contribution statement

**Luca Congiu:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Enrico Botta:** Writing – review & editing, Methodology, Conceptualization. **Mariangela Zoli:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Data availability

No data was used for the research described in the article.

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