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Behavioral paradigms for studying pro-environmental behavior: A systematic review

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Abstract

In view of global environmental deterioration and climate change, researchers from multiple fields of the behavioral sciences examine the determinants of pro-environmental behavior. Research on pro-environmental behavior is dominated by the use of self-report measures, which relates to critical validity problems. Some of these problems can be addressed by studying consequential behavior in behavioral paradigms (i.e., systematically arranged situations of actual environmental relevance). However, pro-environmental behavior paradigms have been scattered across disciplines, and many researchers may not be aware of the wealth of available paradigms. The present review aims to acquaint researchers across disciplinary borders with the behavioral paradigms developed to study pro-environmental behavior in different domains. A systematic literature search revealed 99 ad hoc paradigms and five validated paradigms of pro-environmental behavior. I review how different authors have succeeded in implementing the consequences of pro-environmental behavior in standardized field, laboratory, or online situations, point to caveats in the use of behavioral paradigms, and illustrate how researchers can select a paradigm for their own research.

Keywords Pro-environmental behavior · Paradigm · Experimental model · Behavioral task · Behavioral measurement

Human behavior is causing environmental deterioration, climate change, and global biodiversity loss (IPBES, 2019; IPCC, 2014; Ripple et al., 2017). Addressing these issues requires widespread behavioral changes across actors and scales (Nielsen et al., 2021). Attempts to induce such changes are likely to be most effective when building on a thorough understanding of when, how, and why people consume and conserve resources, dispose of their waste, advocate for environmental causes, and engage in other behaviors of ecological relevance. These behaviors have been studied under a variety of names (Larson et al., 2015). For the purpose of this review, I use the term pro-environmental behavior to refer to those human behaviors that produce environmental benefits relative to alternative behaviors (Lange & Dewitte, 2019a; Steg & Vlek, 2009).

Although pro-environmental behavior is defined by its environmental consequences, most pro-environmental behavior researchers do not study behavior with actual environmental consequences (Lange et al., 2018). Instead, they focus on the observation of verbal behavior, that is, on self-reports of pro-environmental behavior or participants' responses to hypothetical scenarios or intention items. The popularity of self-report measures for the assessment of pro-environmental behavior is understandable. Self-report items can easily be adapted to refer to whichever behavior a researcher is interested in and they can easily be embedded in large-scale (online) surveys. In addition, self-reports of pro-environmental behavior have been demonstrated to be useful in some domains. For example, Kaiser and colleagues have developed a measurement tool that aggregates self-reports across multiple pro-environmental behaviors to distinguish between individuals based on their environmental attitude (e.g., Kaiser & Wilson, 2004; Kaiser & Lange, 2021; Kaiser et al., 2018). However, self-reports of pro-environmental behavior also face serious limitations when being used for other purposes (Lange & Dewitte, 2019a).

First, retrospective self-reports will often be inaccurate when used to quantify the characteristics of a pro-environmental behavior (e.g., the frequency of recycling or duration of showering). People are unlikely to be good observers of their own behavior and likely to be affected by poor memory

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and reporting biases (Gifford, 2014; Kormos & Gifford, 2014). Second, when used to study the relationship with constructs that are assessed via self-report as well (e.g., values or personality traits), self-reports of pro-environmental behavior will lead to systematically inflated relationships due to common-method variance (Podsakoff et al., 2003). Third, relying on retrospective self-reports likely discourages the use of experimental designs (Lange et al., 2018). Such self-reports cannot detect behavior change right away but require costly longitudinal designs that provide participants with some time to change their behavior in everyday life before they can report this change on a self-report measure. Some researchers try to avoid these costs of longitudinal designs by studying people's verbal responses to hypothetical questions or intention items. However, when using such verbal responses as outcome measures in experimental research, researchers run into a fundamental external validity problem. Verbal responses involve other contingencies than the corresponding pro-environmental behaviors and as such, there is no basis to generalize the results from a verbal-response experiment to a non-verbal pro-environmental behavior of interest (Wille & Lange, under review). This is illustrated, for example, by studies that obtain fundamentally different results depending on whether participants make hypothetical or consequential choices (e.g., Klein & Hilbig, 2019) and it may also account for imperfect individual-difference correlations between intention statements and observed behavior (Sheeran, 2002).

The problems of using self-reports highlight the need for alternative means to study pro-environmental behavior. This need can be addressed by observing actual pro-environmental behavior or its products (e.g., the amount of household food waste, Li et al., 2021) in naturally occurring field situations. Naturalistic field experiments may be the most appropriate way to examine how effective an application (e.g., an intervention based on acquired behavior change knowledge) can be under the noisy conditions that are characteristic of naturally occurring situations[1]. However, that same noise will often complicate the systematic analysis of functional determinants and underlying mechanisms (e.g., the acquisition of behavior change knowledge). When studying naturally occurring pro-environmental behavior, researchers often need to give up a large measure of experimental control: they may not be able to ascertain random assignment to experimental conditions, standardized exposure to experimental materials, or independence of observations. As a consequence, a systematic experimental analysis of pro-environmental behavior and the acquisition of basic behavior change knowledge are difficult when relying on the observation of pro-environmental behavior in naturally occurring situations (Lange & Dewitte, 2019a).

An alternative approach to the study of pro-environmental behavior is the use of behavioral paradigms (also referred to as behavioral tasks or experimental models). Behavioral paradigms are systematically arranged model situations that mirror the same critical contingencies (i.e., the same relationships between environment, behavior, and its consequences) as the situations they are supposed to model. Individuals can be exposed to these model situations in a standardized way and researchers have experimental control over the model parameters. Following this approach, behavioral scientists have devised models of how people, for example, respond in the presence of conflicting stimulus dimensions (e.g., the Stroop task, MacLeod, 1992) or cooperate with others (e.g., the ultimatum or dictator game; Forsythe et al., 1994). Such behavioral paradigms can be implemented in the laboratory or in digital environments (e.g., through embedding them in online surveys), but also in the field. Prosocial behavior, for example, has been studied by observing how many passersby picked up an intentionally dropped pen or how many letters left on the pavement found their way into the mailbox (e.g., Levine et al., 1994; Nettle et al., 2011). In contrast to observing behavior in naturally occurring situations, field paradigms are arranged in a standardized way (e.g., pens are dropped while walking at a fixed pace, at a fixed distance from the pedestrian whose behavior is to be observed). In contrast to behavioral paradigms in laboratory or online settings, field paradigms are typically set up in a way that the observed individuals do not know that they participate in a study.

A behavioral paradigm is suitable for the externally valid study of behavior when it involves the same critical contingencies (or theoretical parameters; Schmuckler, 2001) as the situation(s) to which results are ultimately supposed to be generalized (Lange & Dewitte, 2019a). Sharing money in a dictator game or picking up a lost pen, for example, generates benefits for someone else at a personal cost, and it can be argued that these contingencies adequately reflect the contingencies involved in many naturally occurring prosociality situations. If a manipulation in a behavioral paradigm changes these contingencies in the same way as it would in naturally occurring prosociality situations, results can be expected to generalize from the paradigm to the modeled situation. These considerations of external validity also illustrate why inconsequential verbal responses to hypothetical scenarios or intention items are typically poor models of naturally occurring situations (e.g., Klein & Hilbig, 2019):

[1] I use the term "naturally occurring" to refer to those situations and behaviors that researchers wish to generalize their results to and that they ultimately wish to understand. I prefer this term to other common terms such as "actual", "real", or "real-world" situations/behaviors, because I consider study situations to be just as actual, real, and part of the real world as situations that naturally occur outside the context of a research study.

verbal responses relate to other contingencies than the behaviors to which they supposedly correspond.

The use of behavioral paradigms offers interesting opportunities for the experimentally controlled and externally valid analysis of pro-environmental behavior. It allows studying the functional determinants and underlying mechanisms of pro-environmental behavior under controlled conditions. In addition, behavioral paradigms can serve as a wind channel (Berger & Wyss, 2021a): They facilitate the pretesting of novel interventions for pro-environmental behavior change in controlled, noise-reduced settings before these interventions are translated into practice and evaluated in naturally occurring situations. However, the use of behavioral paradigms in pro-environmental behavior research has been scarce and scattered. Many researchers in the field may not be aware of the wealth of available paradigms and of the possibility to use behavioral paradigms for their own research on pro-environmental behavior. For this reason, the present paper is aimed at providing a comprehensive overview of the behavioral paradigms that have been used to study pro-environmental behaviors.

Methods

Scope and distinctions

Articles were included in the present review if they describe a behavioral paradigm of pro-environmental behavior or report data obtained from such a paradigm. Study procedures were considered behavioral paradigms of pro-environmental behavior if they involved observing the behavior of individuals in systematically arranged situations and if the observed behavior met the defining criterion of pro-environmental behavior (i.e., if it produced environmental benefits, Lange & Dewitte, 2019; Steg & Vlek, 2009; Stern, 2000). In naturally occurring situations, the production of these benefits usually involves some individual costs, at least in the short term (Gifford, 2011; Kaiser, 2021): organic products tend to be more expensive than conventional ones, separating waste requires time and effort, and colder showers and living rooms may be less comfortable. An adequate pro-environmental behavior paradigm will reflect both these types of consequences: environmental benefits and individual costs. In principle, these consequences will need to be arranged in a way that requires participants to make a trade-off between maximizing environmental benefits and minimizing individual costs. This is not to say that there are no pro-environmental behaviors that also produce benefits for the individual (e.g., saving electricity will relate to environmental and individual monetary gains). In fact, the present review revealed that there are also behavioral paradigms that feature individual benefits of pro-environmental behavior (e.g., Fanghella et al., 2021), but those paradigms as well involve individual costs that necessitate a trade-off. Where no trade-off between valued consequences is required (i.e., where people can produce environmental benefits at no cost), behavior in a behavioral paradigm can be expected to be largely invariant and thus informative.

All behavioral paradigms included in the present review thus involve a trade-off between some kind of environmental consequence and some kind of individual consequence. One exception are social dilemma games that require the management of a common resource pool and that are often considered as models of pro-environmental or sustainable behavior (e.g., Berger & Wyss, 2021a; Zelenski et al., 2015). These games typically do not involve consequences for the natural environment (i.e., the defining criterion of pro-environmental behavior), but only for the participating players, who need to trade off (short-term) individual gains and (long-term) collective gains. Using social dilemma games as pro-environmental behavior paradigms thus reflects the view that environmental consequences are only relevant because they eventually lead to collective consequences for humankind. Whether this assumption is justified likely depends on the research question at hand. Here, I include social dilemma games despite their lack of environmental consequences to make the present review as comprehensive and informative as possible for researchers who search for an adequate behavioral paradigm for their research purposes.

In this review, I make a distinction between *ad hoc* behavioral paradigms and *validated* behavioral paradigms of pro-environmental behavior. While ad hoc paradigms are designed or adapted specifically to address a particular research question at hand, validated paradigms have undergone formal validation before being used in the same, previously validated form to answer substantive research questions in separate studies. Validation of behavioral paradigms can take different forms. On the one hand, researchers may test if they have been successful in implementing a trade-off between valued environmental and individual consequences by examining if participants' behavior in a behavioral paradigm is sensitive to these consequences. This sensitivity may be considered a prerequisite for obtaining externally valid results: if naturally occurring situations involve a trade-off between valued environmental and individual consequences, then so should a paradigm that adequately models those situations (Lange & Iwasaki, 2020). On the other hand, researchers may want to use behavioral paradigms as measures or indicators of a psychological characteristic (e.g., a person's propensity to behave pro-environmentally or environmental attitude; Kaiser & Lange, 2021; Lange & Dewitte, 2021b). In this case, validation of behavioral paradigms rather involves addressing psychometric questions of, for example, construct validity (Yoder et al., 2018). In the following, I consider behavioral paradigms to be validated

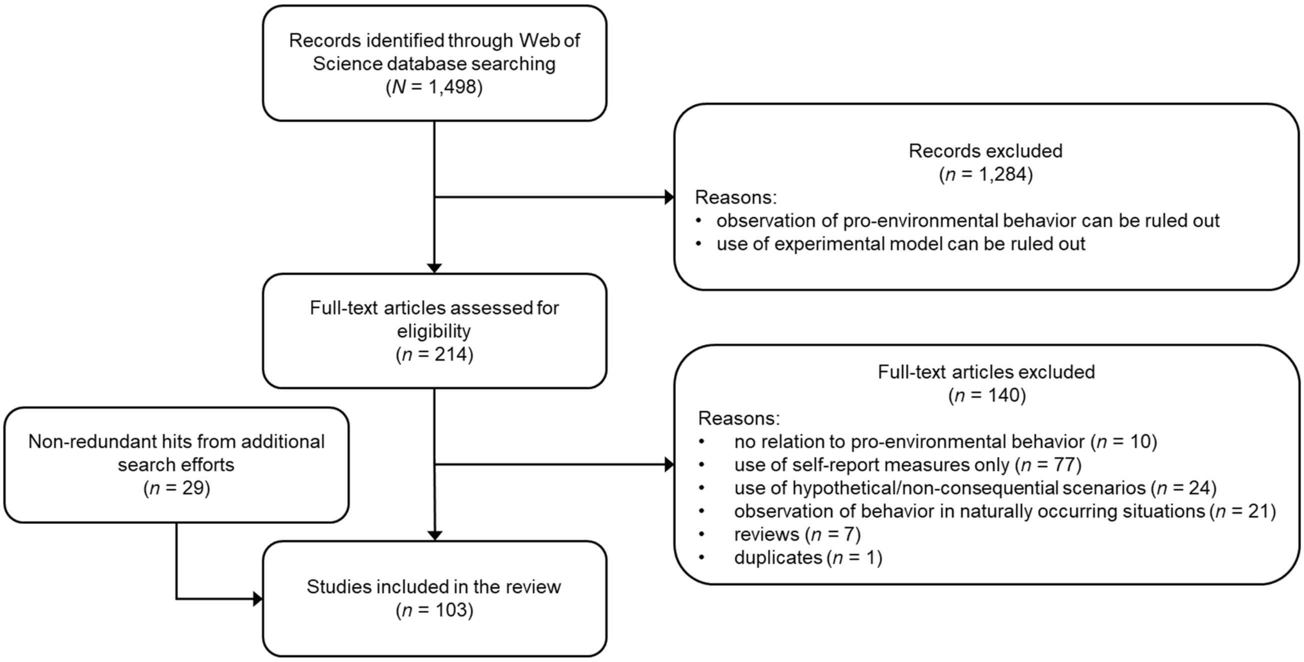

Fig. 1 Flow chart depicting the selection of articles for this systematic review

if the literature search revealed any evidence for their validity in terms of sensitivity to implemented consequences or convergence with conceptually related measures.

Search strategy

On July 22, 2021, I searched the literature indexed in the Web of Science (all fields) for records that featured at least one term related to pro-environmental behavior and at least one term related to the use of behavioral paradigms. The behavior-related terms in the search string were: environment* behav*, proenvironment* behav*, recycling behav*, conservation behav*, ecological behav*, environmentally relevant behav*, environmentally responsible behav*, ecologically relevant behav*, ecologically responsible behav*, environmentally friendly behav*, environmentally significant behav*, environmentally supportive behav*, climate friendly behav*, sustainable behav*, green behav*, and environmental action*. The paradigm-related terms in the search string were: paradigm, task, experimental model, behav* measurement, measuring behav*, laboratory, consequential choice, consequential behav*, actual choice, actual behav*.

This first literature search yielded 1498 hits. Based on screening the title and abstract of these records, I downloaded 214 potentially relevant records for full-text screening. Of those records, 140 did not report attempts to study pro-environmental behavior in an arranged situation and were excluded. Of the 74 included articles, 60 reported data from ad hoc pro-environmental behavior paradigms, ten made use of validated paradigms, and four used both at least one validated and one ad hoc paradigm.

I made two efforts to further increase the comprehensiveness of the present review. First, I screened the articles citing (on the Web of Science and Google Scholar) the initial validation studies of the previously identified validated behavioral paradigms, which led to the identification of 14 additional papers. Second, I consulted a recent review on the measurement of pro-environmental behavior (Lange & Dewitte, 2019), which led to the identification of 15 additional papers. Hence, I identified a total of 103 publications reporting behavioral paradigms for the study of pro-environmental behavior (see Fig. 1).

Results

Review of the 103 selected articles revealed 99 ad hoc paradigms and five validated paradigms of pro-environmental behavior. Sixteen articles reported data from more than one distinguishable behavioral paradigm and the five validated paradigms were described in more than one paper each (minimum two, maximum 11 articles per paradigm). While the review revealed a diverse range of behavioral paradigms, several major clusters (i.e., donation decisions, product choice, recycling behavior, resource consumption, social dilemma games) emerged and I organized the presentation of ad hoc paradigms along these clusters. After this presentation, I turn to the review of the identified validated paradigms of pro-environmental behavior.

Ad hoc behavioral paradigms of pro-environmental behavior

A first class of behavioral paradigms includes observations of pro-environmental donation behavior. All 22 studies listed in Table 1 provided participants with a standardized opportunity to donate money to an environmental organization. Such donation opportunities clearly reflect a trade-off between environmental and individual consequences: participants can either keep the money or donate parts of it to an organization that can be expected to invest the money into the protection of the environment. In most cases, the money that participants can either keep or donate is provided to them by the experimenter, either in the form of remuneration for study participation, performance-contingent rewards, or performance-independent bonus payments. It is also common practice to give participants a chance to win extra money in a lottery and to ask them how much they will donate should they win this lottery. Of note, two studies did not provide participants with a monetary endowment but approached participants (who did not know that they participated in a study) in the field to ask if they would donate their own money (Alpizar et al., 2008; Priolo et al., 2016). Many studies allow donations to a range of different environmental organizations. Researchers typically analyze the amount or proportion of the endowment that is being donated, but some researchers also used dichotomized outcome measures (e.g., because of violated distribution assumptions, Brick & Sherman, 2021).

Table 2 displays an overview of a second class of behavioral paradigms, that is, of tasks involving the choice between products that differ in their ecological footprint. These product-choice tasks seem to come in two major varieties: either participants receive some budget to spend on either sustainable or conventional products, or they simply have to choose between a sustainable and a conventional product option. In the first case, the costs of pro-environmental behavior (i.e., of choosing the sustainable option) are commonly implemented by offering the sustainable product at a price premium. In other words, participants have to spend more of their money or must limit themselves to buying fewer products if they choose for sustainable products. In the second case, the costs of pro-environmental behavior are the opportunity costs of not receiving the conventional product. For example, participants who chose a notepad made from recycled paper in the study by Cornelissen et al. (2008) did not receive an alternative notepad made from non-recycled paper. The fact that 48% of the participants in that study chose the non-recycled option suggests that this option must have been related to some (perceived) benefits, benefits that participants had to forgo when choosing the recycled option. With regard to the environmental benefits modeled in product-choice tasks, it should be noted that the view that choosing the "sustainable" product option relates to a smaller ecological footprint is an oversimplification. For example, recycled paper, plastic cups, and organic t-shirts might be less impactful than non-recycled paper, Styrofoam cups, and conventional t-shirts on *some* dimensions of environmental well-being, but they may have larger impacts on *other* dimensions. One way to control the environmental consequences of product options is illustrated by the study by Duchêne et al. (2021), who arbitrarily linked one option to environmental benefits (i.e., donations to an environmental organization) and one option to environmental costs (i.e., donations to a fossil-fuel association). A final point worth noting is that pro-environmental product choice can also be investigated in a standardized way without participants being aware of their study participation (i.e., in field paradigms, Dodds et al., 2018; Klimas & Webb, 2018; Schwartz et al., 2020).

Researchers have also developed behavioral paradigms of recycling behavior in the field and laboratory. Field paradigms involved, for example, providing naive participants with a paper notice (Barker et al., 1994) or handbill (Geller et al., 1977) and then observing how they dispose of these materials, or simply asking participants to sign up for a roadside recycling program (Weigel & Newman, 1976). In addition to these three field paradigms, Table 3 includes ten paradigms that have been embedded in laboratory or classroom studies. All these paradigms involve providing participants' with a recyclable item (e.g., as part of a mock study or as packaging of a reward for study participation) in the presence of recycle bins and observing whether participants use the recycle bin to dispose of the recyclable item. To the extent that recycling of the used items contributes to resource conservation, participants' behavior in these paradigms has actual environmental consequences. In some cases, recycling behavior was also costly, for example, because waste had to be separated or rinsed before disposal. However, some behavioral paradigms involved no clear cost of recycling as recycling and trash bin were equally accessible to the participants and waste did not have to be separated. In the absence of such costs, behavioral recycling paradigms may produce very high rates of recycling behavior (e.g., 95% in the study by van Horen et al., 2018), which may be problematic because ceiling effects can mask potential effects of experimental manipulations.

A further class of behavioral paradigms involves assigning participants to a standardized task that can be completed by using resources (i.e., water, electricity, paper) in a more or less efficient way. Table 4 displays 14 examples of such resource-consumption paradigms, many of which have been designed to closely resemble everyday household actions

Table 1 Overview of behavioral paradigms involving donation decisions

	Country	Setting	Origin of the money	Size of endowment	Receiving organization
Alpizar et al. (2008)	Costa Rica	National park	Participants own money	Not applicable	National park
Barclay & Barker (2020)	US	Laboratory	Unconditionally provided by experimenter	2 USD	Sierra Club
Bauer & Menrad (2019)	Germany	Laboratory	Remuneration for participation	3 euros	Gold Standard (carbon offsetting)
Brick & Sherman (2021)	US	Laboratory	Remuneration for participation	10 raffle tickets for $50 Amazon.com gift card	Environmental student organization
Clements et al. (2015)	US	Online	Unconditionally provided by experimenter	0.50 USD	WWF
Clot et al. (2016)	France	Classroom	Chance to win a lottery	Potentially 30 euros	Unspecified environmental organization
Fleiß et al. (2020)	Austria	Laboratory	Unconditionally provided by experimenter	variable across trials	Atmosfair (carbon offsetting) | Save the Rainforest | WWF
Ibanez et al. (2017)	France	Laboratory	Performance-contingent reward	20 euros	WWF | Nicolas Hulot Foundation for Nature and Man | Greenpeace
Ibanez et al. (2019) - task 1	France	Laboratory	Unconditionally provided by experimenter	10 euros	WWF | Foundation for Nature and Man | France Nature Environnement | environmental student association
Karapetyan & d'Adda (2014)	Sierra Leone	Schools	Remuneration for participation + performance-contingent reward	Variable across participants, but at least 5000 Leones (=1.25 USD)	Conservation Society of Sierra Leone
Kim et al. (2021)	US	Online	Remuneration for participation	Unspecified	Unspecified environmental organization
Lange & Dewitte (2021a)*	Belgium	Laboratory	Participation fee	2 euros	Carbon+Alt+Delete (carbon offsetting)
Lange & Dewitte (2021b)	Belgium	Online	participation fee	4 euros	Carbon+Alt+Delete (carbon offsetting) | OroVerde (rainforest protection)
Lavallee et al. (2019)	Taiwan	Laboratory, online	Chance to win a lottery	Potentially 1000 New Taiwan Dollars	Unspecified environmental organization
Mahardika et al. (2020)	US	Online	Participation fee	0.10 USD	Campaign for the production of compostable shopping bags
Odou et al. (2019)	France	Laboratory	Chance to win a lottery	Potentially 50 euros	WWF | Greenpeace | UNICEF | Red Cross
Priolo et al. (2016)	France	University campus	Participants own money, returned to them at the end	Not applicable	Blue Region (fictitious environmental organization supposedly represented by the experimenter)
Riepe et al. (2021)	Germany, France, Norway, Sweden	Online	Remuneration for participation	Unspecified	World Wide Fund For Nature | North Atlantic Salmon Conservation Organization
Schmitt et al. (2019) - task 2	Germany	Laboratory	Remuneration for participation	4 euros	WWF
Stikvoort et al. (2016)	Sweden	Laboratory	Remuneration for participation	200 Swedish krona	Greenpeace
van Horen et al. (2018) - task 1	The Netherlands	Laboratory	Chance to win a lottery	Potentially 25 euros	WWF

Table 1 (continued)

<table>
<tr><th></th><th>Country</th><th>Setting</th><th>Origin of the money</th><th>Size of endowment</th><th>Receiving organization</th></tr>
<tr><td>Vesely & Klöckner (2018)</td><td>Norway</td><td>Laboratory</td><td>Performance-contingent reward</td><td>Up to 10 euros</td><td>Environmental Defense Fund | Greenpeace | National Wildlife Federation | The Nature Conservancy | PETA | Rainforest Alliance | WWF</td></tr>
</table>

Note. *Data from a donation-based paradigm with the same characteristics are presented in Lange et al. (2020).

(e.g., washing dishes, using a vacuum cleaner, making tea, preparing a meal). Researchers using such paradigms typically record how much of a given resource is used to complete the task and because of the environmental benefits related to resource conservation, behavior in these paradigms can be viewed as a type of pro-environmental behavior. Saving resources in behavioral paradigms is often linked to personal costs in the form of effort that participants have to make in order to complete the task in more resource-efficient ways. For example, participants may need to take additional steps (e.g., reading instructions, adjusting vacuum cleaner suction control, removing objects on the ground before vacuuming) or perform tasks in a more careful way (e.g., to ensure that only as much water is boiled as needed for a tea) in order to save resources. Resource-consumption paradigms have also been embedded in larger laboratory studies, e.g., by instructing participants to print the informed consent form (which could be done using more or less paper and ink, Moussaoui et al., 2020) or testing the qualities of a towel (which could be done using more or less water, Liu et al., 2019; Zhang et al. 2021). Another interesting possibility is illustrated by the study by Fanghella et al. (2021) who linked participants' behavior in a virtual washing machine task to environmental and individual consequences that can also be implemented in online studies. Choosing energy-efficient washing machine settings in their study led to environmental benefits (donations to an environmental organization) and personal costs (effort), but also to bonus payments implemented to mirror the personal gains that are typically related to saving energy.

Table 5 displays 13 versions of social dilemma games that have been used as pro-environmental behavior paradigms. In contrast to the behavioral paradigms presented thus far, social dilemma games typically require that multiple participants interact with each other. Most of the games involved participants making choices that affect their own payoff and the state of a common pool (and thus the payoff of all players in the game). In public good games, participants can contribute points to the common pool and the common pool points are then multiplied and distributed among all players. In commons dilemma games, participants can extract points from the common pool, the points left in the pool are multiplied for subsequent rounds of the game, and once the pool is depleted, none of the players can extract points anymore. Typically, participants' behavior in these games does not relate to environmental consequences, but only affects the payoff of the players involved in the game. Notable exceptions are the studies by Alpizar and Gsottbauer (2015) and Tarditi et al. (2020) who linked the number of points in the common pool to donations being made to environmental organizations. Table 5 also reveals that game-based behavioral paradigms differ in group size (i.e., in the number of participants playing the game together), in the number of rounds

Table 2 Overview of behavioral paradigms of product choice behavior

	Country	Setting	Description	Environmental benefits	Personal costs
Barber et al. (2014)	US	Laboratory	Bidding for organic and conventional wines in an auction	Smaller ecological footprint of purchased organic wines	Investment of own money (some endowment was provided)
Cornelissen et al. (2008) - task 1	Belgium	Laboratory	Spending part of the remuneration on sustainable or conventional products	Smaller ecological footprint of sustainable products	Sustainable products sold at a price premium
Cornelissen et al. (2008) - task 3	Belgium	Laboratory	Choosing between notepads made from recycled or non-recycled paper	Smaller ecological footprint of recycled notepad	Missing out on potential benefits of the non-recycled notepad
Dodds et al. (2018)	Canada	Festival	Choosing between conventional and organic festival t-shirts	Smaller ecological footprint of organic t-shirt	Organic t-shirts were sold at price premium
Duchêne et al. (2021)	France	Banks, asset management companies, laboratory	Investing a budget in green, brown, or neutral assets (with different return rates) in a portfolio choice task	Green assets related to pro-environmental donations, brown assets to anti-environmental donations to a fossil-fuel association	Missing out on profitable neutral and brown assets
Hanss & Böhm (2013)	Norway	Online	Spending a budget on sustainable or conventional products in a virtual supermarket	Smaller ecological footprint of sustainable products	Sustainable products sold at a price premium
Ho et al. (2020) - task 1	Taiwan	Laboratory	Choosing between vegetarian and non-vegetarian meal boxes as reward for participation	Smaller ecological footprint of vegetarian box	Missing out on potential benefits of the non-vegetarian box
Klein & Hilbig (2019)	Germany	University campus	Keeping an endowment vs. Spending it on one sustainable or two conventional chocolate bars	Smaller ecological footprint of sustainable chocolate bar	Investment of money, missing out on the more plentiful conventional alternative
Klimas & Webb (2018)	US	University coffee shops	Choosing between sustainable and conventional coffee when redeeming a voucher (for a free bakery item with the purchase of a cup of coffee)	Smaller ecological footprint of shaded coffee	Shaded coffee was sold at price premium
Kovács et al. (2020)	Hungary	Schools	Choosing between recycled, conventional, and plastic-covered paper for an origami task	Smaller ecological footprint of the plastic option	Missing out on the shiny plastic-covered paper option
Moore & Yang (2020) - task 1	US	Laboratory	Choosing between plastic and Styrofoam cup for drinking water during study break	Smaller ecological footprint of (recyclable) plastic cup	Missing out on potential benefits of the Styrofoam cup
Richter et al. (2018)	Austria	Laboratory	Spending a budget on sustainable or conventional products in a virtual supermarket	Smaller ecological footprint of sustainable products	Sustainable products sold at a price premium
Schmitt et al. (2019) - task 3	Germany	Laboratory	Choosing between two fair-trade chocolate bars, one with and one without palm oil	Smaller ecological footprint of the palm-oil-free option	Missing out on the potential benefits of the palm-oil chocolate bar
Schwartz et al. (2020) - task 1	US	Laboratory	Spending a budget on sustainable or conventional products in a virtual supermarket	Smaller ecological footprint of sustainable products	Sustainable products sold at a price premium

Table 2 (continued)

	Country	Setting	Description	Environmental benefits	Personal costs
Schwartz et al. (2020) - task 2	Chile	Supermarket	Choosing between a free plastic bag and an eco-friendly reusable bag using a flyer provided at the checkout	Smaller ecological footprint of reusable bag	Reusable bag had to be bought, alternative was free
Taube & Vetter (2019)	Germany	Online	Choosing between sustainable and conventional products in a virtual supermarket	Smaller ecological footprint of sustainable products	Missing out on potential benefits of the conventional products
Urban et al. (2019)	Czech Republic	Online	Spending a budget on sustainable or conventional products in a virtual supermarket	Smaller ecological footprint of sustainable products	Missing out on potential benefits of the conventional products

that participants play, and in the way researchers frame the task. While some researchers simply inform participants about the task contingencies (e.g., the number of players and their starting budgets, the size of the common pool, the multiplication factor for points in the common pool), others explicitly liken the payoff-determining choices made in the game to environmentally relevant choices made in everyday life (e.g., recycling, transportation choices). When inspecting Table 5, readers familiar with the environmental/ behavioral economics literature may miss some popular examples for the use of social dilemma games (e.g., Hauser et al., 2014; Jacquet et al., 2013; Milinski et al., 2008; Tavoni et al., 2011). Due to the present focus on behavioral paradigms with actual consequences for the natural environment, the search algorithm was not optimized to detect these additional game-based publications. Nonetheless, while necessarily incomplete, the examples listed in Table 5 should provide a good overview of the contingencies typically implemented in social dilemma games.

Finally, Table 6 provides an overview of other pro-environmental behavior paradigms that do not fit into the larger categories described above. These paradigms entail, for example, asking participants whether they would like to participate in a pro-environmental event (e.g., a beach-cleaning activity or information event) or sign a petition supporting an environmental cause. Event participation and petition signing generally relate to environmental consequences if the event or the petition does, and they involve obvious costs in terms of time and effort. When used as behavioral paradigms in study surveys, these behaviors often involve privacy costs as well: participants need to provide their names and/or contact information to participate/sign the petition in an otherwise anonymous survey situation. Another type of behavioral paradigm that can easily be included in survey situations is information seeking behavior, that is, giving participants the opportunity to voluntarily read, watch, or listen to extra information on a topic of environmental relevance. Information seeking behavior may have environmental consequences if the provided information promotes pro-environmental behavior change. Table 6 further lists a few examples of standardized situations researchers created to give participants an opportunity to make an effort for the benefit of the environment (e.g., turning off the lights, attaching an anti-ads sticker to their mailbox, testing a new bus route/organic shop). While such behavioral paradigms typically involve the observation of binary one-time decisions, researchers have also designed computerized tasks that allow studying *how much* time and effort participants invest in order to generate environmental benefits. In these tasks, participants can opt to work more on inherently unrewarding tasks or to spend more time on the study. The more they work or the more time they spend, the more money is donated to an environmental organization after the study.

Table 3 Overview of behavioral paradigms of recycling behavior

	Country	Setting	Description	Environmental benefits	Personal costs
Barker et al. (1994)	US	Campus mail facility	Choosing how to dispose of a bogus notice sent to student's mailbox, with garbage and recycling bins present in the mail facility	Resource conservation	Effort of using recycling bin (vs. Littering, using the trash bin)
Baur & Haase (2015)	Germany	Classroom	Choosing how to dispose of packaging material of candy obtained for filling in a questionnaire, with recycling bins present in the classroom	Resource conservation	Effort of separating waste
Geller et al. (1977)	US	Grocery store	Choosing how to dispose of a handbill distributed by a confederate, with garbage and recycling bins present in the store	Resource conservation	Effort of using recycling bin (vs. Littering, leaving the handbill in the cart)
Huffman et al. (2014)	US	Laboratory	Being asked to dispose of (recyclable and non-recyclable) study materials after a mock study, with a trash bin and recycling bin present	Resource conservation	Effort of separating study materials for disposal
Ibanez et al. (2019) - task 2	France	Laboratory	Being asked to throw headphone cover tissues (used for a different task) into a recycling bin	Resource conservation	Effort of throwing away the cover tissues
Linder et al. (2021)	Singapore	Laboratory	Being asked to rinse and dispose of a yoghurt cup after a taste test, with a trash bin and recycling bin present	Resource conservation	Effort of rinsing the cup
Longoni et al. (2014)	US	Laboratory	Being (implicitly) asked to dispose of (recyclable and non-recyclable) study materials after a mock study, with a trash bin and recycling bin present	Resource conservation	Effort of separating and disposing study materials
Meng & Trudel (2017)	US	Laboratory	Testing pairs of scissors and being asked to dispose of the resulting pieces of paper afterwards, with a trash bin and recycling bin present	Resource conservation	None (materials did not have to be separated and bins were equally accessible)
Moore & Yang (2020) - task 2	US	Laboratory	Encountering a researcher-provided, recyclable bottle in the hallway, with a trash bin and recycling bin present	Resource conservation	Effort of recycling the bottle
Trudel & Argo (2013) - study 2-4	Canada, US	Laboratory	Testing pairs of scissors and being asked to dispose of the resulting pieces of paper afterwards, with a trash bin and recycling bin present	Resource conservation	None (materials did not have to be separated and bins were equally accessible)
Trudel & Argo (2013) - study 5	US	Laboratory	Being provided with an empty can for a creative writing task and asked to dispose of the can afterwards, with a trash bin and recycling bin present	Resource conservation	None (materials did not have to be separated and bins were equally accessible)

Table 3 (continued)

	Country	Setting	Description	Environmental benefits	Personal costs
van Horen et al. (2018) - task 1	The Netherlands	Laboratory	Being asked to dispose of a piece of paper when leaving the laboratory, with a trash bin and recycling bin present	Resource conservation	None (materials did not have to be separated and bins were equally accessible)
Weigel & Newman (1976) - task 3	US	Private households	Being asked to participate in roadside recycling	Resource conservation	Effort of separating waste

Validated behavioral paradigms of pro-environmental behavior

In addition to the numerous examples of ad hoc paradigms listed above, the literature search has also revealed five validated pro-environmental behavior paradigms (Table 7). In the following, I will briefly describe these paradigms and the validation efforts that have been undertaken to validate them. Search results also include several studies that have used these paradigms to address substantive research questions. The following section will refer to these studies as well to provide the reader with a comprehensive overview of what is known about the properties of validated pro-environmental behavior paradigms and provide links to the task materials wherever possible.

The FISH simulation is a framed multi-round commons dilemma game (Gifford & Aranda, 2013; Gifford & Gifford, 2000; Gifford & Wells, 1991). Participants act as fishers deciding how many fish to extract from a common pool. Each extracted fish corresponds to a small monetary payment (e.g., \$0.10, Zelenski et al., 2015). After each round, the fish left in the common pool regenerate at a rate chosen by the experimenter. Participants can play the game together with other participants or computer-simulated fishers. As typical for social dilemma-based paradigms of pro-environmental behavior, behavior in the simulation produces consequences for the participant and fellow fishers, but not for the natural environment. Main outcome measures of the task include restraint (i.e., the proportion of fish taken by an individual) and efficiency (i.e., the proportion of fish taken relative to the regeneration rate), which have been interpreted as reflections of preservationist and sustainable resource-management practices, respectively (Gifford & Hine, 1997). Restraint and efficiency have been found to be highly correlated ($r = .99$, Chen & Gifford, 2015). In terms of validation, correlations have been reported between restraint in the FISH simulation and self-reported pro-environmental values (Sussman et al., 2016) and pro-environmental motivation (Baxter & Pelletier, 2020). The task has been used to study the effect of manipulating task parameters, such as regeneration rate (Liu & Hao, 2020), uncertainty about pool size and regeneration rate (Hine & Gifford, 1996), and the simulated restraint of computer-simulated fellow players (Sussman et al., 2016). Other studies have experimentally exposed participants to nature imagery (Zelenski et al., 2015), climate change information (Liu & Hao, 2020), or relatedness primes (i.e., words such as "caring" or "include", Prentice & Sheldon, 2015) and then analyzed participants' behavior in the FISH simulation as a function of these manipulations. According to the latest version of the task manual (http://web.uvic.ca/~esplab/?q=tools), the FISH simulation is available by request to the authors and can be used at no charge.

Table 4 Overview of behavioral paradigms of resource consumption behavior

	Country	Setting	Description	Environmental benefits	Personal costs
Birau & Faure (2018)	France	Laboratory	Testing pairs of scissors by cutting circles with no instructions on circle size and the number of paper sheets to be used	Less paper consumption	Effort of fitting circles on fewer paper sheets
Cornelissen et al. (2008) - task 2	Belgium	Laboratory	Using scrap paper to complete writing task	Less paper consumption	Effort to use paper efficiently (fitting text on smaller space)
Fang & Sun (2016)	Taiwan	Laboratory	Washing dishes	Less water consumption	Effort to use water efficiently
Fanghella et al. (2021)	unspecified	Online	Choosing settings for 10 loads of laundry in a virtual washing machine task	Donation to an environmental association linked to saved energy	Effort of reading and implementing energy saving instructions
Fuss et al. (2011)	Germany	Laboratory	Washing dishes (12 place settings, soiled in a standardized way)	Less water, energy, detergent consumption	Effort to use resources efficiently
Liu et al. (2019)	China	Laboratory	Testing a towel	Less water consumption	Effort of using resources efficiently
Moussaoui et al. (2020) - task 2	Switzerland	Laboratory	Printing the study consent form	Less paper and ink consumption	Effort of selecting most efficient printer settings, lower print quality
Oliveira et al. (2016)	UK	Residence hall kitchen	Preparing instant noodles using a solid plate electric cooker	Less energy consumption	Effort of using resources efficiently
Sauer & Rüttinger (2004) - study 1	Germany	Laboratory	Preparing two cups of tea with a kettle	Less energy and water consumption	Effort to use resources efficiently (to measure the required amount of water)
Sauer & Rüttinger (2004) - study 2&3	Germany	Participants' kitchen	Completing 10 self-recorded test trials with a kettle	Less energy and water consumption	Effort to use resources efficiently (to measure the required amount of water)
Sauer et al. (2002)	Germany	Laboratory	Using a vacuum cleaner to clean a floor with a standard amount of distributed sand	Less energy consumption	Effort to use suction control
Wiese et al. (2004)	Germany	Laboratory	Using a vacuum cleaner to clean a floor with objects standing in the way	Less energy consumption	Effort of removing objects/adjusting suction control settings before vacuuming
Withanage et al. (2014)	Singapore	Laboratory	Preparing two packets of instant noodles, with a kettle and an induction cooker present	Less energy consumption	None (using the kettle was easier than using the induction cooker)
Zhanget al. (2021)	China	Laboratory	Testing a towel	Less water consumption	Effort of using water efficiently, poorer evaluation results (ostensibly linked to bonus payment)

Table 5 Overview of social dilemma games used as behavioral paradigms of pro-environmental behavior

	Country	Setting	Type of game	Payoff rule	S	R	Personal consequences	Environmental consequences	Framing of points
Alpizar & Gsottbauer (2015)	Costa Rica	Local school, community center	Threshold public goods game for donations	If public points exceed a threshold, a donation is made	4	4	Private points for one round are paid out, no pay out of the public points	Yes, public points are donated to environmental organization	Time and effort spent recycling
Berger & Wyss (2021a)	Switzerland	Classroom	Commons dilemma	Points left in pool are multiplied & distributed among players	3	1	Points are paid out	No	None
Brucks & van Lange (2008)	The Netherlands	Laboratory	Commons dilemma	Points left in pool are multiplied for following rounds	5	12	Private points relate to lottery chance (ostensibly)	No	None
Czap et al. (2018)	US	Laboratory	Dictator game	Points contributed are added to another player's payoff	2	20	Points are paid out	No	Use of tillage in farming
Marek (2018)	France	Laboratory	Social dilemma choice task	Choosing the more profitable option generates costs for all players	4	10	Points are paid out	No	Travel mode choice
Menges et al. (2021)	Germany	Classroom	Public goods game	Points contributed are multiplied & distributed among players	6	10	Points are paid out	No	Units of waste to be disposed of
Mosler (1993)	Switzerland	Laboratory	Commons dilemma	Points left in pool are multiplied for following rounds	25	19	Points are paid out	No	Catching of fish
Nolan (2017)	US	Laboratory	Public goods game	Points contributed are multiplied & distributed among players	8	5	Private points relate to lottery chance (ostensibly)	No	Recycling decisions
Przepiorka & Diekmann (2020)	Switzerland	Laboratory	Inter-temporal social dilemma choice task	Choosing the more profitable option generates accumulating costs for all players	5	10	Points are paid out	No	None
Revollo-Fernández et al. (2016)	Mexico	Laboratory, on a fishing island	Commons dilemma	Points left in pool are multiplied for following rounds	5	10, 20	Points are paid out	No	Catching of fish

Table 5 (continued)

	Country	Setting	Type of game	Payoff rule	S	R	Personal consequences	Environmental consequences	Framing of points
Tarditi et al. (2020) - task 1	Switzerland	Laboratory	Commons dilemma	Points left in pool are (ostensibly) multiplied for following rounds	n/s	45	Points relate to lottery chance	Yes, public points relate to chance to cause the buying of a parcel of rainforest	None
Tarditi et al. (2020) - task 2	Switzerland	Laboratory	Public goods game	Points contributed are (ostensibly) multiplied for following rounds	n/s	45	Points relate to lottery chance	Yes, public points relate to chance to cause the buying of a parcel of rainforest	None
Torres-Guevara & Schlüter (2016)	Colombia	School	Public goods game	Points contributed are multiplied & distributed among players	5	1	Points are paid out	No	None

Note. S = group size, R = number of rounds, n/s = not specified.

The Greater Good Game (GGG, Klein & Hilbig, 2018; Klein et al., 2017) is based on a typical dilemma structure as well, but in contrast to the FISH simulation, behavior in the GGG has actual consequences for the natural environment. The game involves multiple players and rounds. In each round, participants can decide what they want to do with a small monetary endowment. They can either keep the money, contribute it to the common pool, or donate it to an environmental account. Contributions to the common pool are multiplied and then distributed among all players. Contributions to the environmental account are also multiplied and then donated to an environmental organization. Hence, participants do not only have to make a trade-off between individual benefits and environmental benefits, but also between environmental benefits and prosocial benefits they can generate through their behavior in the GGG. The task yields two outcome measures, an *s* parameter reflecting how much money is kept versus contributed to a non-selfish goal and an *e* parameter reflecting how much of the contributed money is donated to the environmental account versus common pool. The GGG has been validated through manipulating task contingencies: Participants shied away from donating to the environmental account when doing so led to extra subtractions from the common pool (i.e., *e* decreased when pro-environmental behavior hurt in-group cooperation). When contribution to either account led to subtraction from the other account (i.e., when pro-environmental and prosocial behavior hurt each other), the *s* parameter increased, indicating that most participants preferred to keep the money (Klein et al., 2017). Behavior in the GGG has been analyzed as a correlate of personality traits and political orientation (Klein et al., 2017, 2019) and as a function of nature exposure (Klein & Hilbig, 2018) and social exclusion in a Cyberball game (Klein & Rudert, 2021). Full GGG instructions can be found at https://osf.io/zw2ze/.

On the Pro-Environmental Behavior Task (PEBT, Lange et al., 2018), participants make a series of choices between two response options, typically framed as means of transportation. After each choice, participants have to wait a variable amount of time for the next choice trial. Choosing the environmentally friendly option (e.g., the bicycle) involves larger waiting time costs than choosing the environmentally harmful option (e.g., the car), that is, participants can save time and finish the task more quickly when choosing the environmentally harmful option. However, choosing that option also produces an actual environmental consequence. Whenever participants choose the environmentally harmful option, a number of extra lights are illuminated, wasting some energy and producing some CO_2 emissions. In other words, participants can either minimize the time they have to wait on the task (by choosing the environmentally harmful option) or the amount of energy that is wasted during their study participation (by choosing the environmentally

Table 6 Overview of remaining miscellaneous behavioral paradigms of pro-environmental behavior

	Country	Setting	Description	Environmental benefits	Personal costs
Event participation					
Brites & Morsello (2017)	Brazil	Rural community	Being offered to participate in researcher-designed activities to monitor the exploitation of non-timber forest products	Conservation of harvested species	Effort of monitoring
Donmez-Turan & Kiliclar (2021)	Turkey	Lab	Being asked if interested to take part in a sustainability event	Propagation of environmental knowledge	Effort of informing the experimenter about contact details and associated privacy costs, prospective effort of attending the event
Ho et al. (2020) - task 2	Taiwan	Lab	Being asked if interested to take part in a beach-cleaning activity	Support of beach-cleaning activity	Effort of providing contact details and associated privacy costs, prospective effort of attending the event
Weigel & Newman (1976) - task 2	US	Private households	Being asked to participate in a roadside litter pick-up and to recruit others to do so	Resource conservation, cleaner environment	Effort of picking up litter and motivating others
Petition signing					
Gulliver et al. (2020) - study 2&3	US	Online	Following a link to a petition against coal mining (petition signing not observed)	Support of anti-coal-mining campaign	Time and effort to follow the link and potentially sign the petition, potential privacy costs of petition signing
Rabinovich et al. (2012) - task 1	UK	Lab	Choosing to ask political representative to sign pro-environmental manifesto	Support of pro-environmental policy	Effort of providing contact details and associated privacy costs
Rees et al. (2015)	Germany	Lab	Being offered to sign a petition against plastic waste	Support of anti-plastic policy	Effort of signing the petition and (potentially) associated privacy costs
Weigel & Newman (1976) - task 1	US	Private households	Being asked to sign up to three environmental petitions and to circulate petition for further signatures	Support of environmental campaigns	Effort of signing and associated privacy cost, effort of collecting further signatures
Information seeking					
Rabinovich et al. (2012) - task 2	UK	Lab	Being offered to take leaflets about sustainability and climate change	Propagation of environmental knowledge	Transporting the leaflets
Schmitt et al. (2019) - task 1	Germany	Lab	Surfing the internet after self-reporting on their palm-oil-related knowledge	Propagation of environmental knowledge	Opportunity cost of not searching for other content
van Horen et al. (2018) - task 3	The Netherlands	Online	Opening an email about a sustainability initiative	Propagation of environmental knowledge	Effort of opening the email
Time and effort tasks					
Dorner (2019)	Australia	Lab	Working on a secondary task to reduce the environmental damage (i.e., donation reduction) that is produced by a primary task (completed for personal payment)	Remaining donation was given to tree planting charity	Effort to work on secondary task, time on secondary task cannot be used to work on primary task (and thus to earn personal payment)

Table 6 (continued)

	Country	Setting	Description	Environmental benefits	Personal costs
Gulliver et al. (2020) - study 1	Australia	Online	Voluntarily completing up to 100 simple math and word questions to generate environmental donations	Donations earned by one randomly drawn participants were donated to an anti-coal-mining campaign	Time and effort to complete the voluntary task
Kacperski & Kutzner (2020)	Germany	Lab	Choosing between fast and green driving routes in a navigation app	Green routes saved co_2, realized through donations to carbon offsetting	Extra time to be spent on attention task when choosing green routes
Taube et al. (2018)	Germany	Online	Choosing between fast and green driving routes	Green routes saved CO_2, realized through donations to carbon offsetting	Extra time to be spent watching car ride video when choosing green routes
Turning off lights					
Moussaoui et al. (2020) - task 1	New Zealand	Lab	Having the opportunity to turn off the computer before leaving the laboratory	Less energy consumption	Effort of pressing a button
Murtagh et al. (2015)	UK	Lab	Having the opportunity to turn off the lights before leaving the laboratory	Less energy consumption	Effort of operating the light switch
Others					
Bamberg (2002) - task 1	Germany	University bus route	Choosing whether or not to use an experimenter provided ticket to conduct a bus route test	Emission savings in contrast to car (not realized in study)	Effort of using the bus
Bamberg (2002) - task 2	Germany	Organic shop	Choosing whether or not to redeem a voucher for testing an organic shop	Smaller ecological footprint in contrast to conventional products (not realized in study)	Effort of going to the shop
Hamann et al. (2015)	Germany	Private households	Choosing whether or not to attach a provided anti-ads sticker to one' mailbox	Less paper use	Effort of attaching the sticker, missing out on advertisements/free newspapers

Table 7 Overview of validated behavioral paradigms of pro-environmental behavior

	First description	Countries	Settings	Environmental benefits	Personal costs
FISH simulation	Gifford & Wells (1991)	Canada, US, China	Laboratory, online	None	Missing out on extracting money from the pool
Greater Good Game (GGG)	Klein et al. (2017)	Germany, US, UK	Laboratory, online	Financial support of environmental organization	Missing out on bonus payments and in-group cooperation
Pro-Environmental Behavior Task (PEBT)	Lange et al. (2018)	Belgium, Japan	Laboratory	Saving of energy and CO_2 emissions	Additional waiting time
Work for Environmental Protection Task (WEPT)	Lange & Dewitte (2021)	Belgium	Laboratory, online	Financial support of environmental organization	Additional effort
Carbon Emission Task (CET)	Berger & Wyss (2021a)	US, UK, Switzerland	Classroom, online	Elimination of CO_2 emissions	Missing out on bonus payment

friendly option). Validation studies in Belgium (Lange et al., 2018) and Japan (Lange & Iwasaki, 2020) have found that participants take these consequences into account when choosing between PEBT options: they are more likely to choose the environmentally friendly option when doing so involves smaller waiting time costs or larger environmental benefits. Hence, the PEBT involves the trade-off between valued individual and environmental consequences that is characteristic of many naturally occurring situations of environmental relevance. Behavior on the PEBT has also been examined as an indicator of a person's propensity to behave pro-environmentally. In support of its construct validity, the proportion of environmentally friendly PEBT choices has been found to be positively related to self-reports and observations of other pro-environmental behaviors and to measures of constructs that are commonly considered as psychological antecedents of pro-environmental behavior (e.g., environmental attitude, concern, identity, values; Lange et al., 2018; Lange & Dewitte, 2021b). In addition, PEBT choices have excellent split-half reliability (r_{SB} = .98) and good one-month test-retest reliability (r = .81; Lange et al., 2018; Lange & Dewitte, 2021b). Observations of PEBT performance have been studied as a correlate of personality traits and cognitive flexibility (Lange & Dewitte, 2019b) and as a function of experimentally induced positive affect (Lange & Dewitte, 2020) and social observability (Lange et al., 2020). The PEBT has also been used to experimentally validate a measure of environmental attitude (Kaiser & Lange, 2021). The PEBT software can be downloaded at https://osf.io/tcnza/. As the PEBT also involves some hardware (i.e., lights to be illuminated when participants choose the environmentally harmful option), PEBT studies are typically conducted in the laboratory. First attempts have been made to translate the task into an online setting where the environmental consequences of PEBT choices are simulated rather than real (Stern et al., 2021; see also Austin & Converse, 2021, for a study published after the present literature review).

The Work for Environmental Protection Task (WEPT, Lange & Dewitte, 2021a) has resulted from an attempt to link participants' choice behavior to actual environmental consequences in a way that also allows application in online settings. On the WEPT, participants can opt to exert extra effort on a number identification task and for every page of numbers they complete, an amount of money is donated to an environmental organization. Along the lines of the PEBT, WEPT behavior has been shown to be sensitive to the implemented individual costs (i.e., the length of number pages to be completed) and environmental benefits (i.e., the amount of money being donated), and to be related to observations of other pro-environmental behaviors and conceptually related measures (Lange & Dewitte, 2021a). The number of completed WEPT pages has also been found to be positively correlated to the proportion of environmentally friendly PEBT choices (Lange & Dewitte, 2021b). Split-half reliability has been estimated to be r_{SB} = .92 (Lange & Dewitte, 2021a). The original version of the WEPT has been completed to the benefit of an organization supporting rainforest protection, but the task can be easily adapted to target other environmental benefits. By changing the organization receiving the donations that participants generate through their WEPT performance, researchers can study behaviors that benefit, for example, individual species, local cleanup events, political campaigns for environmental protection, or even non-environmental goals (e.g., architectural conservation, prosocial charity). The WEPT is available for use at https://osf.io/gpzy3/.

While PEBT and WEPT involve behavioral costs in terms of time and effort, pro-environmental behavior on the Carbon Emission Task (CET, Berger & Wyss, 2021a) comes at a monetary cost. CET participants are repeatedly offered bonus payments without being required to do any effort to receive the bonus. However, when participants choose to forego a bonus payment, they effectively contribute to the reduction of global CO_2 emissions. Dependent on the number of foregone bonus payments, CET researchers retire previously purchased CO_2 emission certificates and thus reduce the amount of CO_2 that other actors within the European cap-and-trade emission system are able to emit in the future. In a series of validation studies (Berger & Wyss, 2021a), participants‘ choice behavior on the task was found to be sensitive to the size of the bonus payment and to the amount of CO_2 emissions they could prevent through foregoing the bonus. In addition, CET behavior was related to self-report-based measures of environmental concern, belief in climate change, and carbon footprint as well as to performance in a one-shot commons dilemma game (see Table 5). Split-half reliability has been estimated to be $r_{SB} = .94$. Berger and Wyss (2021a, b) also examined whether CET behavior relates to individual differences in political orientation and gender and whether participants' demonstrated sensitivity to the CO_2 consequences of the CET correlates with their belief in climate change. The CET can be downloaded at https://osf.io/qjxbu.

Discussion

The present review revealed a diverse range of behavioral paradigms that have been used to study pro-environmental behavior in laboratory, online, and field studies. For example, research participants have been observed making standardized donation decisions or product choices, wasting or conserving energy while performing household tasks, disposing of their study materials, or signing petitions for pro-environmental causes. Most of these paradigms were developed in an ad hoc fashion: researchers designed them based on conceptual considerations to answer a particular research question and the same paradigm was rarely used more than once. In addition, a handful of more formally established behavioral paradigms were identified that have been validated and repeatedly used to answer substantive research questions.

Given the wealth of available behavioral paradigms identified in the present review, it may seem surprising that research on pro-environmental behavior is still heavily reliant on self-report measures (Lange et al., 2018; Steg & Vlek, 2009). One reason for the limited uptake of pro-environmental behavior paradigms may be that researchers are simply not aware of the available set of paradigms that have already been tried and tested. Many types of behavioral paradigms are predominantly used by researchers in a particular discipline and may be unknown to researchers in other disciplines. For example, while social dilemma games seem to be particularly popular in behavioral and ecological economics (Table 5), research using resource consumption tasks has primarily been published in ergonomics journals (Table 4). I hope that the present review can help acquaint researchers across disciplinary borders with the behavioral paradigms developed to study pro-environmental behavior in different fields.

Another factor limiting the popularity of behavioral paradigms may be the costs of their implementation relative to the costs of using verbal responses to self-report measures, intention items, or hypothetical scenarios. Many behavioral paradigms require specific hardware and a level of experimenter-participant interaction that can only be achieved when participants are tested individually or in small groups in the laboratory. However, for many research purposes, the additional resources required to study actual pro-environmental behavior in behavioral paradigms may be well-invested given the clear external validity gains in comparison to the study of inconsequential verbal responses. Recall that the external validity of experimental results depends on the degree of overlap between the contingencies involved in the experimental situation and the contingencies involved in the naturally occurring situation of interest. In the case of verbal responses and hypothetical scenarios, this overlap is necessarily zero: the behavior in the study situation does not lead to the same consequences in the same way as the behavior of actual interest. In the case of behavioral paradigms, the overlap may not be perfect, but at least there is some basis to expect generalization, because the study situation mirrors (some of) the critical contingencies involved in some naturally occurring situations of actual environmental relevance. In addition, the review revealed several behavioral paradigms that can be implemented at a very low cost. For example, donation decisions or petition signing tasks, but also most of the validated paradigms reviewed above, can easily be added to online studies to rapidly collect data from large samples of participants.

When selecting a behavioral paradigm for their study, researchers should primarily look for a paradigm that adequately represents (i.e., that involves the same critical contingencies as) the situation(s) to which they would ultimately like to generalize their results. Generalizability or external validity is not an absolute feature of a behavioral paradigm, but can only be determined relative to the situation it is supposed to model (Lange & Dewitte, 2019; Lange & Iwasaki, 2020). For example, behavioral paradigms that involve behavioral costs in terms of time and effort (e.g., the PEBT or WEPT) may be adequate representations of effortful and time-intensive pro-environmental behaviors (i.e., picking up litter, using a slower means of transportation), but poor models of everyday product choices and monetary investment decisions. Similarly, social dilemma games may not be reflective of the decision between a local and an (equally priced) imported piece of fruit, but they may allow modelling environmentally relevant situations with multiple interdependent actors.

An experimental manipulation can be expected to change pro-environmental behavior in a behavioral paradigm if it changes the critical contingencies governing this behavior. Being allowed to listen to their favorite music, for example, may increase participants' pro-environmental behavior on the PEBT or WEPT as it decreases the aversiveness of spending extra time on the task. This effect can be expected to generalize to other behaviors when listening to one's favorite music changes the costs of these behaviors in a similar way. This will likely apply to behaviors such as picking up litter or using slower means of transportation, but not to choosing between organic and conventional products in the supermarket, taking more or less time under the shower, or voting for a party supporting pro-environmental policies. Before selecting an adequate behavioral paradigm, it is thus crucial to (1) clarify the range of situations of interest, (2) analyze the contingencies governing behavior in these situations, and (3) analyze how these contingencies would be changed by the experimental manipulation of interest. Once these questions are answered, a behavioral paradigm can be selected or designed that involves the same critical contingencies and in which the experimental manipulation changes these critical contingencies in a similar way.

Another dimension that may be advisable to take into account when selecting behavioral paradigms is their degree of validation. Validation studies allow testing if researchers have been successful in implementing the task contingencies of interest (e.g., a trade-off between valued environmental and individual consequences) or evaluating whether behavior in behavioral paradigms qualifies as a measure of a specific person characteristic (e.g., a person's propensity to engage in pro-environmental behavior). In addition, increased reliance on validated, established paradigms reduces researcher degrees of freedom (Flake & Fried, 2020) and may critically contribute to the systematic accumulation of evidence (Lange, 2019). Comparing and integrating results across studies will likely be easier if researchers use the same established paradigm in a standardized way than when each of them creates their own ad hoc paradigm.

The present review also suggests that not all types of pro-environmental behavior have received equal attention in prior behavioral paradigm research. For example, while there are some paradigms that involve observing pro-environmental behavior in the political domain (e.g., petition signing), these behaviors are likely to involve very different contingencies than other political behaviors (e.g., organizing or participating in protests or collective climate actions). Similarly, many researchers have used behavioral paradigms to study product choice behavior, but choices mostly involved fast-moving consumer goods. It seems questionable to generalize results from such choices to infrequent but environmentally impactful investment decisions (e.g., about the installment of solar panels, the purchase of energy-efficient household appliances, or the switch to an environmentally friendly energy provider or pension fund). Designing behavioral paradigms of political behaviors or infrequent investment decisions is probably more challenging than studying petition signing or the choice between chocolate bars, but given the environmental impact of those former behaviors, the search for appropriate means to study them appears worthwhile.

Conclusions

Researchers across scientific disciplines have been creative in their design of behavioral paradigms of pro-environmental behavior. These paradigms can address many of the limitations related to the use of self-report measures and hypothetical scenarios. When based on a careful analysis of the contingencies involved in naturally occurring situations of environmental relevance, they can allow for the externally valid analysis of pro-environmental behavior and its determinants under experimentally controlled conditions. Attempts to understand how people manage, protect, and conserve natural resources may thus benefit from the increased use and further development of behavioral paradigms, and I hope that the present review can provide some guidance in this respect.

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Open Practices Statement

The search strategy was not preregistered and the search string was progressively adapted to include as many distinct behavioral paradigms as possible. Bibliometric data of all identified publications is being made available in the present article.