ESRI

Working Paper No. 645

December 2019

Encouraging pro-environmental behaviours: a review of methods and approaches

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Abstract: Many urgent environmental problems can be mitigated with more sustainable use of resource. An acknowledgement of which is a growing interest among policy practitioners in encouraging pro-environmental behaviour change initiatives. The effect of anthropic pressure on the environment is long known and the first pro-environmental behaviour studies date back to the middle 1970s. Despite this, the scientific literature has not yet answered several questions: what are the most suitable ways to encourage behavioural changes? What are the barriers to project implementation? What are the long run effects of behavioural change projects? With this in mind, this contribution offers a review of the existing literature on behavioural change case studies and provides a categorisation of treatments and guidelines for successful project implementation. Five different approaches have been considered: education and awareness, social influence, relationship building, incentives and nudges, which have been used in experimental studies. On balance the case studies suggest that all approaches are suitable but their selection should be based on specific objectives and target population. Interestingly, the choice of the behaviour to change is rarely discussed before project implementation. This analysis also highlights that little is known on whether behaviour change projects achieve sustained pro-environmental behavioural change over time.

Acknowledgements: Funding from the Department of Housing, Planning and Local Government is gratefully acknowledged.

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Encouraging Pro-Environmental Behaviours: a review of methods and approaches

1. Introduction

There is widespread evidence that the global environmental crisis is caused by humans. As climate data suggest, the rise in temperatures makes time frames for the transition to a low-carbon society shorter and the need for environmental policy efforts greater [92]. Moving to a production system based on renewable and clean sources of energy is essential to mitigate climate change and represents a priority for environmental policy worldwide. In addition to this well-known problem, ecosystem pollution and natural resource depletion are issues of utmost importance. However, negative externalities caused by business sectors are not the only source of environmental pressure, as people's actions and behaviours in their daily life also have negative consequences. For example, it is estimated that 16 percent of emissions in the European Union are caused by household energy consumption [38], whereas urban waste disposal is a major concern worldwide for its environmental costs in terms of emissions to soil, water and air [133]. Despite scientific research increasingly emphasising the contribution of people's unsustainable practices to environmental problems, efforts to raise awareness are at present insufficient and non-systematic [92]. This situation requires a dramatic change in people's habits towards more sustainable lifestyles. Increasing walking and cycling rates, reduce single use items and recycling are all examples of behaviour changes with small impact on individuals' routine that bring sizeable positive effects to the environment when implemented at large scale. The idea that "everybody can make a difference" for the environment has led researchers to investigate ways to effectively communicate pro-environmental messages and stimulate behavioural changes. Behaviour change studies were developed with the objective of encouraging the wider audience to adopt environmentally conscious behaviours and take responsibilities for their actions.

Theories and models for behaviour change have a long-standing tradition, with the experiment proposed by Pallack and Cummings in 1976 for energy saving being one of the oldest reported behaviour change study [99]. To date the uptake of behaviour change models is relatively limited and results are mixed [2]. The lack of effective dissemination is one of the greatest limitations of replication of behaviour change models. For example, many public authorities have implemented community-level projects to improve environmental awareness, change unsustainable behaviours, and increase conservation. These projects are important because they have the potential to affect behaviour on a medium to large scale. However, difficulties arise with respect to retrieval of project learnings and information, and absence of systematic ways to measure project success are strong barriers for replication of such projects in other communities. Therefore, the following questions arise: Are environmental behaviour change projects effective? What behaviour change approaches are mostly used? What are the most effective methods for changing behaviours? Are there barriers to their implementation?

In this contribution we review the literature on behaviour change methods and applications in the environmental sustainability domain and address the questions posed above. Reviews of behaviour change approaches have been published already, however they usually focus on a single behaviour, e.g. recycling [133], single behaviour change approach, e.g. social influence studies [2] or specific context, for example

sustainability in the workplace [144]. This study gathers all types of behaviour change projects regardless of policy context or behavioural theories adopted by primary studies. In addition, this review is not restricted to scientific contributions but also includes technical reports and projects retrieved from on-line sources. We identify a theoretical framework of behaviour change approaches to allow a better understanding of their usefulness for behavioural change and empirical methods used to assess options of behaviour change development. Secondly, we categorise the studies on the basis of their approach and identify key factors for success plus barriers that lead to failure. We then discuss knowledge gaps and best practices for a successful implementation of behaviour change strategies to encourage resource conservation and environmental protection.

The rest of the paper is organised as follows. In the next section a description of the theoretical background is provided. The main motivations to behaviour change and five different approaches are introduced. The third section depicts the methodological approach to data collection, indicating the sources and keywords that were used to collect primary sources. The fourth section describes the results, which consist of descriptions of treatment types, environmental policy areas of implementation, main learnings for each of the five approaches. Discussions of the results as well as potential barriers to behaviour change implementations are discussed in section five. The sixth section discusses policy indications for the implementation of a research behaviour change project and the last section offers some conclusions.

2. Background

Approaches to behaviour change are grounded on the idea that most actions in people's daily lives provoke an unjustified waste of resources and correcting behaviours allows higher environmental sustainability [1]. Within the psychological literature there are several theories that depict why individuals behave in a certain way and how behaviours can be effectively changed. In general, it is acknowledged that human behaviour is influenced by internal and external factors [135]. Internal factors comprise people's beliefs, values, attitudes and emotions. Environmental knowledge is also an important internal driver of pro-environmental behaviours [69]. External factors are related to the context in which individuals behave and make choices, i.e. formal regulation, social norms, cultural taboos [135]. Therefore, actions aiming to change human behaviour should consider both internal and external factors and provide effective prompts to behavioural change. To that end we follow a categorisation of behaviour change methods proposed by Wallen and Daut [135] comprising (1) education and awareness, (2) outreach and relationship building, (3) social influence, (4) nudges and behavioural insights and (5) incentives. Other similar categorisations have also been proposed [67, 94, 134]. The following sub-sections briefly explain the categorisation and form of the framework for the review of the extant literature.

2.1. Education and awareness

Education and awareness (EAA) methods consist of providing information materials such as handouts, newsletters, advertising campaigns, posters and magazines. It is one of the most common methods, often the default approach, to foster behaviour change. The model relies on the knowledge-deficit assumption [98], which suggests that in the absence of relevant information, behaviour change will not occur. Changing attitudes or knowledge may trigger new behaviours [114]. Scientific evidence suggests that EAA is particularly effective when individuals are motivated by a pre-existing interest in environmental issues and willingness to engage in pro-environmental behaviours, however, pro-environmental attitudes do not always

foster pro-environmental behaviour [40, 103, 116]. The disparity between concern for an environmental issue and associated behaviours highlights the barriers to achieving behavioural change, including social, informational, economic and psychological barriers [79].

2.2. Outreach and relationship building

Outreach and relationship building (ORB) relates to all activities designed to provide services and goods to improve pro-environmental attitudes and behaviours. Such activities can take the form of direct and indirect information but it distinguishes from EEA interventions because the focus under ORB is building relationships within communities and among stakeholders [25]. Examples of ORB interventions include workshops, training and community engagement activities (e.g. focus groups and public events). The effectiveness of ORB is especially high when coupled with robust stakeholder and inter-community relations [123]. However, building strong ties among different cohorts of stakeholders is difficult to accomplish. Typically, successful ORB projects require several training sessions, focus groups and a large number of meeting with moderators, where participation is high and stakeholders exchange opinions and build trustworthy relationships [135]. Given the amount of time, money and organisational activities requested for ORB projects, they are less numerous and published assessments of such projects are even fewer.

2.3. Social Influence

The effect of an individual's behaviour on another individual is referred to as social influence (SI). Close social groups such as family, friends, neighbours and other community members are particularly influential on people's behaviour. A SI intervention usually communicates other members' behaviour to stimulate behaviour change. Abrahamse and Steg [2] reviewed common SI applications and classify the approaches in the following categories: Block Leaders and social networks, public commitment making, modelling and feedback. Specifically, Block Leaders are volunteers belonging to the social network of targeted individuals that foster information about certain issues; the underlying assumption is that communication is more effective if conveyed by social network peers [12]. A commitment, or oath, is a promise to engage in a certain behaviour (e.g. reduce water use); they are especially powerful when made in public [18]. Modelling is grounded on social learning theory [7] and consists of using an exemplary person (the 'model') to demonstrate a certain behaviour, with the idea that individuals would engage in behavioural change when a reference model is available. Finally, 'feedback' refer to approaches where the target group receive reports about other people's behaviour; the literature distinguishes between feedback with social comparison (i.e. performance of people that are not targeted) or feedback with group comparison (i.e. performance of all participants of a certain behaviour change project) [66]. The review study by Abrahamse and Steg [2] concluded that methods based on face-to-face interactions (i.e. Block Leaders, modelling and public commitments) were on average more effective than methods comprising feedback provision.

2.4. Nudges and behavioural insights

Nudges and behavioural insights (NBI) originate from various cognitive disciplines and refer to all the instruments that aim to affect the decision context and stimulate the desired behaviour change [135]. The 'choice context', or 'choice architecture', is the set of all possible choices available to an individual. A nudge modifies this choice architecture so that individuals behave in a predictable way and make the desired choice [112]. A typical 'green' nudge is making the desired choice easier or set as default option, e.g. a utility company provides energy from green sources unless otherwise requested, or change size and colours of waste bins to make recycling bins more appealing. Behavioural insights advocate the integration of nudges into public policy design and evaluation [88]. The term 'nudge' is often confusing and it is

not always used appropriately in the literature. Some authors refer to nudges but they may mean other types of treatments. For example, Brick et al. [11] improperly describe their paper as a test between nudge treatments, because the actual treatments are different types of EAA and SI. Behavioural nudges are popular for health behaviours [84, 108], while they are still relatively scarce in the environmental literature, although growing in number.

2.5. Incentives

Another way to encourage pro-environmental behaviours is by means of monetary and non-monetary incentives, i.e. material compensation for individuals that engage in the desired behaviour. Monetary incentives relate to cash bonuses, which can take the form of direct payments, discount fees or potential wins at lotteries, whereas non-monetary incentives are gifts or coupons that cannot be directly exchanged for cash [105]. While incentives are acknowledged to be effective for an initial behaviour change, their sustained effect over time is still debated. For example, Deci et al. [26] argue that motivation to sustain the pro-environmental behaviour is reduced after the incentive is discontinued.

3. Methods

The database for this review includes experiments, projects and experiences that proposed ways of changing people's behaviour towards more environmentally-conscious choices (e.g. increase energy efficiency, increase recycling, reduce waste, reduce water use, etc.). Scientific papers and grey literature, such as technical reports and experiences reported in dedicated websites, are included. Grey literature is useful to avoid publication bias in favour of successful projects and to report studies and projects undertaken by municipalities and other public authorities, which is often unpublished work.

The collection of scientific papers was carried out using two on-line scientific databases, i.e. Scopus and Google scholar. One of the following groups of keywords; "behaviour change", "pro-environmental behaviour change", or "community-based behaviour change" were used in combination with a search area from this ensuing list: "social change", "water", "waste", "environment", "energy efficiency", "climate change", "agriculture" or "sustainability". The collection of grey literature was done through the main Google search engine using the same keyword combinations and inclusion criteria. All search results that did not report a human behaviour change case study were excluded. The first list of identified papers with relevant contributions were snowballed by including relevant papers that either are cited by papers in the original list or cite papers in the list. The criteria for a study's inclusion were: (1) a clear definition of the behaviour to change, (2) detailed description of the actions that were taken to affect the behaviour, (3) definition of the dependent variable, i.e. how the behavioural change was measured, (4) outcome measure, i.e. whether the treatment was successful or not. Most papers depict treatments to affect behaviour that were compared to a control group. In these cases, the success measure is given by the performance of the treatment compared to a control. Some papers only describe one treatment without comparison with a control and the success measure is given by contrasting performances before and after the treatment. Behaviour change studies, even within the academic literature, do not follow a standardised assessment and reporting format, which is a challenge facing all review studies. A standardisation of key attributes across studies would facilitate more formal analyses of behaviour change effects and the robustness of these effects across different contexts, data sets, and even methods [61].

4. Results

4.1. Description of the collected sample

We collected 95 studies, of which 65 were scientific papers reporting experimental studies and 30 were behaviour change projects carried out by public authorities and summarised in technical reports or websites. Some studies were excluded because it was not possible to establish the types of treatment used, so the final dataset contained 82 separate documents. One paper reported 3 case studies, expanding the database to 85 separate case studies. Most scientific papers tested several approaches so the final database contains 155 separate treatments for behaviour change. The collected sources cover a period of almost 40 years, with the oldest paper published in 1982 and the newest in 2019. In terms of experimental approaches, the collected documents can be broadly divided into two main categories: before-after and treatment-control studies. Before-after studies often use only one behaviour change treatment, which is assigned to the entire target population, and its effectiveness is assessed comparing the outcome of interest before and after the treatment. The database comprises 46 documents that can be classified as before-after studies. Treatment-control experiments test n separate treatments on random samples where one group, with no treatment, is used as control. The effectiveness of treatments are evaluated comparing the performances of treated groups with respect to the control group. The number of treatment-control studies in the database is 39.

Figure 1: Success frequency and treatment breakdown

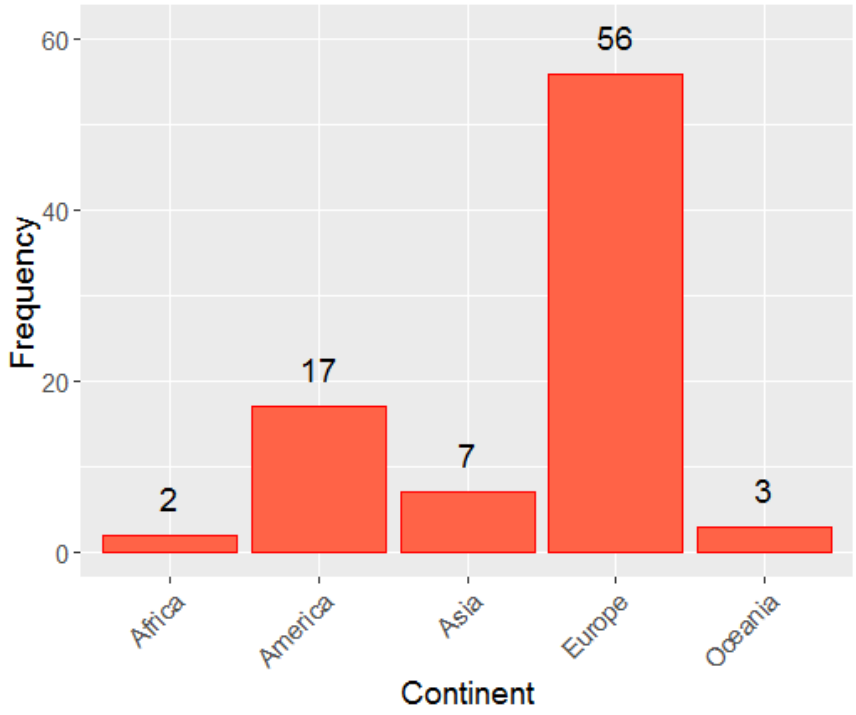
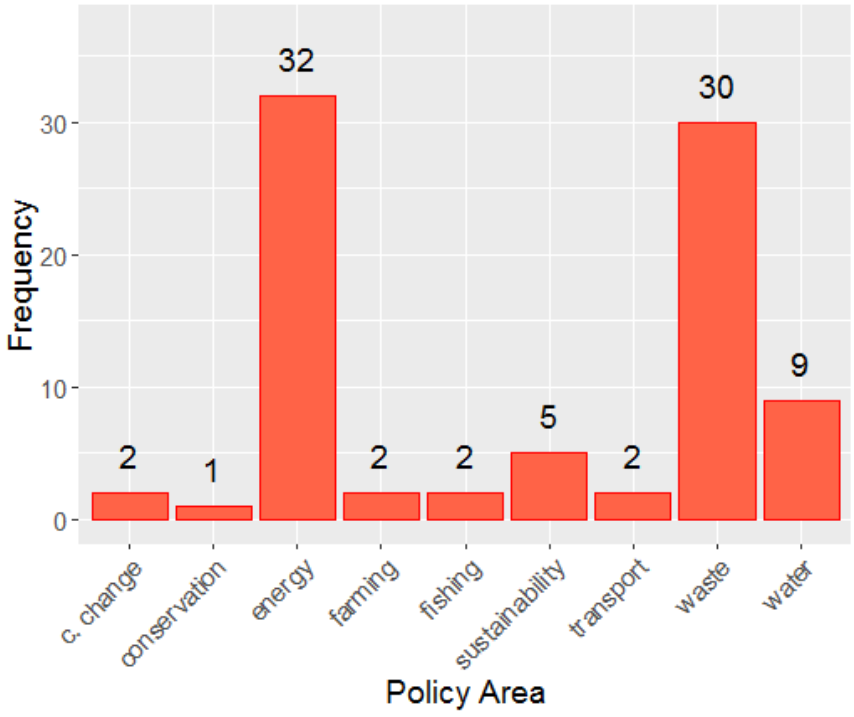


Figure 1 shows the geographical distribution of the database entries. The vast majority of studies were carried out in Europe and North America, which account for 56 and 17 entries respectively. Asia and Oceania are less represented with 7 and 3 studies, while Africa contributed only 2 papers. While most studies target households, it is interesting to note that a substantial minority of papers (about 10 percent), concentrate on workers and students. Some studies target specific segments of the population, for example farmers

Figure 2: Success frequency and treatment breakdown



or fishermen, both represented by 2 studies.

Energy and waste disposal (including recycling) are the sectors where behaviours are most frequently studied, with 32 and 30 documents respectively, followed by water efficiency and stewardship with 9 studies (see Figure 2). Other environmental contexts were much less represented. Sustainability, which accounts for 5 documents, comprises studies that aim to change multiple behaviours or people's general lifestyles. Other behaviours are actions to tackle climate change,[1] transport and wildlife conservation.

A clear classification of treatments is not always easy, as treatments overlap categories. For example, a feedback can be classified as EAA when it is given to households based on their own performances. When feedback reports data of household network or community, then it is considered an SI treatment. Similarly, a public commitment is either SI or ORB based on the type of public occasion. Behaviour change approaches described as 'nudge' were the most difficult to classify as the methods employed often overlap with EAA, SI or ORB approaches. In this respect, we adopt this term only for treatments that affected the choice architecture. Figure 3 reports the breakdown of behavioural treatments. More than 60 percent of the 155 observations is composed of educational and social influence treatments. EAA was studied 57 times, while social influenced accounts for 48 treatments. The predominance of EAA studies is possibly due to the relative ease of application, as it only requires disseminating information materials. Similarly, social influence is time and cost effective as it consists of communicating the behaviour of others, which may

[1]Climate change studies are closely linked (and sometimes overlapping) with other sectors, for example energy and transport. In this classification, a pro-environmental behaviour is considered to be climate change-related if the study explicitly mentions the importance of the behaviour for climate change mitigation.

explain its popularity in behaviour change studies. The lower frequency of other approaches may be due to the scale of resources necessary to undertake them. Building relationships is time consuming, whereas incentives are expensive. Relative to other sectors, nudges are uncommon in the behaviour change environmental literature and appear only in 8 treatments.

Figure 3: Success frequency and treatment breakdown

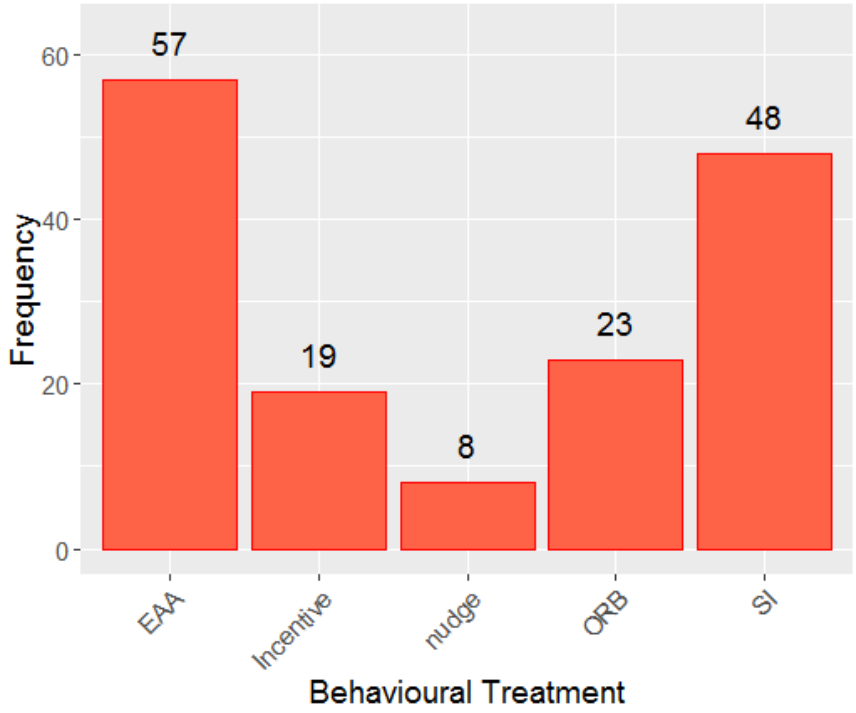


Table 1 shows the breakdown of data analysis techniques by study type. Many before-after studies were not evaluated with formal statistical techniques. Out of 46 investigations, 3 were measured only with descriptive statistics and 32 using simple outcome measurement before and after the treatment (e.g. weight the amount of recycled waste after a communication campaign). Most studies were not peer-reviewed and used EAA and ORB, with a frequency of 15 and 12 respectively. All 39 treatment-control studies were assessed using quantitative statistical methods. ANOVA (ANalysis Of VAriance), which comprises a set of tools to test statistically significant differences between groups, was used once in before-after studies and 13 times in treatment-control studies, other statistical methods were used twice in before-after studies and 18 times in treatment-control experiments. Regression and econometric techniques were used 5 times in before-after studies and 7 in treatment-control. Four studies used qualitative techniques, in particular to evaluate the success of focus groups and scenario analysis.

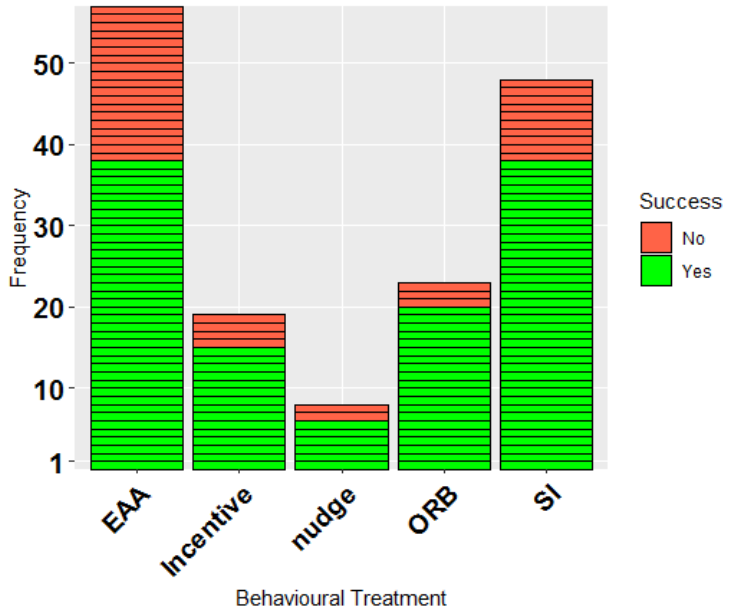
4.2. Profile of successful treatments

Figure 4 shows the breakdown of the 155 treatments by type and frequency of success, as reported by document authors. Despite the large share of successes for all treatment types, which is possibly due to publication bias in favour of successful treatments, there are substantial differences. ORB and incentives are the treatments with the highest success rate, all above 80 percent but they are not frequent in the literature.

Table 1: Data analysis techniques by study types

Analysis	before-after	Treat. vs control	Total
Physical Output measurement	32	0	32
Descriptive Statistics	3	0	3
ANOVA	1	13	14
statistical tests	2	18	20
Econometric modelling	5	7	12
Qualitative	3	1	4
Total	46	39	85

Figure 4: Success frequency and treatment breakdown



EAA is the least effective among the five treatments, with a success rate of about 66 percent, whereas SI obtained 78 percent success rate and nudges 75 percent.

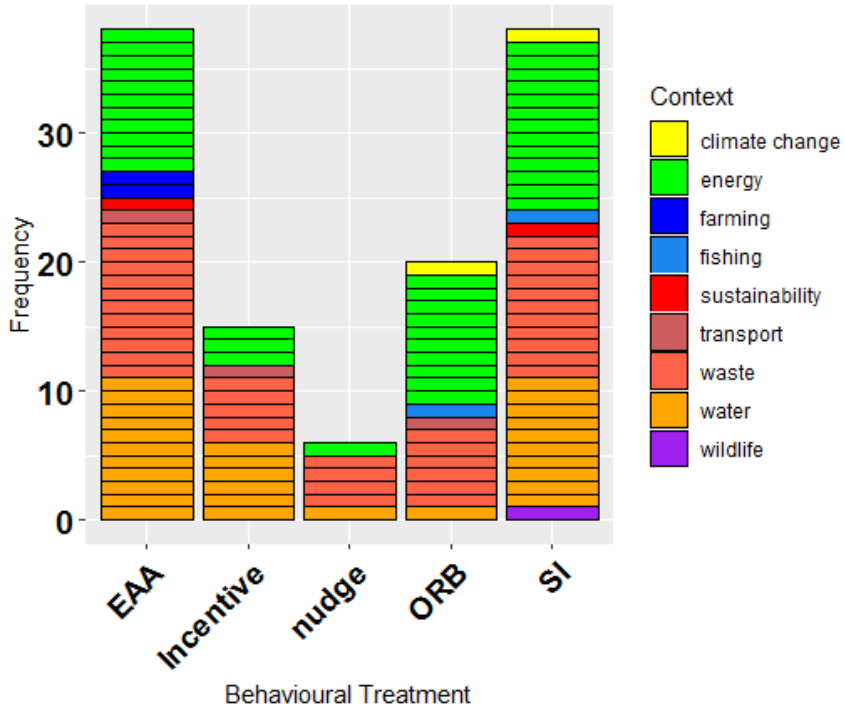
In Table 2 the frequency of successful treatments by policy context is presented. The share of success of behaviour change projects related to energy or waste behaviours exceeds 70 percent, while for projects related to water use the success rate decreases to 60 percent. Despite the small sample size of cases studies related to sustainability projects, it is worthwhile noting that the share of success is very small compared to other policy areas. The studies targeting improved sustainability as a behaviour change ambition usually involve experiments to change several behaviours or lifestyles, which is a broad concept and maybe overly ambitious for a single project. Across other policy contexts the very large success rates (in some cases of 100 percent) reflects their relatively small frequency and, for peer-reviewed papers, possibly reflects publication bias in favour of studies with positive outcomes.

We now concentrate on successful treatments only and observe the success of behaviour change approaches in different policy areas. Figure 5 shows the allocation of successful treatments across fields of

Table 2: Share of successful projects: breakdown by Context (%)

	Energy	Waste	Water	Sustainability	Transport	Farming	Fishing	Climate Change	Wildlife Conservation
Share of success	75	74	61	43	100	67	100	100	100
Frequency	51	49	38	7	3	3	2	2	1

Figure 5: Success frequency and treatment breakdown



application. With respect to energy behaviours, 11 behaviour change treatments were successful using EAA, 13 with SI and 10 with ORB techniques, while nudges and incentives were less frequently successful. Experiments in the sector of waste disposal show a balance of success across treatments similar to energy projects, with EAA and SI the most widely used treatments (12 and 10 uses, respectively) followed by ORB (6 treatments), incentives (5 treatments) and 1 nudge application. Behaviour change for water use and stewardship were also carried out using EAA and SI but, different from energy and waste sectors, incentives were more popular than ORB.

4.3. Main findings

The next sections describe attributes of successful projects for each of the five treatment and detail lessons learned.

4.3.1. Education and Awareness

The earlier quantitative analysis of behaviour change interventions and outcomes shows that EEA is the most common of the five behaviour change methods but has the lowest success rate across the studies examined. Its popularity as a behaviour change intervention potentially reflects the relative ease and limited resources necessary to undertake EEA measures. The lower success rate may reflect the fact that a wide

variety of activities can be classified as EEA, ranging from passive (e.g. posters, leaflets) to more engaging activities (e.g. tailored feedback), and that the efficacy of such measures differs considerably. The most basic EEA interventions, such as the provision of information only, have little impact [70, 143]. For example, information posters on proper tyre inflation had no effect as a behaviour change intervention to improve transport fuel efficiency [143], while information leaflets had no impact on water conservation behaviours [70]. Telling people "what to do" is also ineffective, so top-down programmes are unlikely to be successful [62]. EEA interventions with more success include those containing tailored information [34, 70, 77], while tailored information combined with public pledges to change behaviours leads to even better behaviour change outcomes [62, 70, 77, 124]. The finding that making public commitments affects environmental behaviours echoes a broader literature [63, 64, 136]. Comparative feedback, where performance is contrasted with social norms, is also effective for encouraging behavioural change [48, 74, 117, 124] though, as in most interventions, there are contrary cases [70]. In the latter case, Kurz et al. [70] speculate that failure to find a socially comparative feedback effect may be due to the use of insufficiently strong comparisons. Lede et al. [74] note the importance of the selection process for a relevant comparator group; when a particular social identity is salient, people assimilate their attitudes and behaviours to the norms of the group.

While tailored feedback combined with public commitments to take specific environmental actions are the most effective EEA behaviour change interventions, there are several nuances in the research findings. While information is necessary but not sufficient [143], it is also important where and how the information is delivered. In the case of energy and water conservation Kurz et al. [70] find that the point or location of information delivery has to be relevant to the interaction between people and their environmental behaviours and choices, i.e. the information has to be easily to hand when environmental decisions are being made. Furthermore, the choice of words used to communicate also matter, with messages tailored to local conditions necessary for effective communication [128]. Ma et al. [81] conclude that behaviour changes are highly sensitive and responsive to whether and how feedback is delivered. Face-to-face approaches (i.e. "doorstepping") can be effective for changing public behaviour [44, 107] but without clear and specific aims, and combined with appropriate communications materials, it can be ineffective plus it is resource intensive [128]. An important point by Jiang et al. [62] is that a lack of resources and infrastructure in the context of the desired behavioural change can cause individuals to feel a sense of helplessness. While telling people what to do is ineffective [62], failure to provide the information and resources to help people make their own decisions leads to disempowerment.

The question arises whether people that self-identify as being pro-environmental are more susceptible to behaviour change interventions? Attitudes or behaviour with respect to environmental sustainability have been advocated as possible drivers underpinning choices in the climate-energy sphere but empirical support is not always evident [24, 72, 106]. In a study examining the role of pro-environmental self-identity across diverse pro-environmental behaviours Whitmarsh and O'Neill [139] find it to be a significant behavioural determinant for some but not all pro-environmental behaviours. They find that behaviour-specific self-identity (e.g. pro-water sustainability) exerts the strongest influence on actual behaviours, whereas generic 'pro-environmental' self-identity had a weaker influence on behaviours. They also find that past behaviour independently exerts a strong influence on behavioural intention. More generally, van der Werff et al. [132] argue that environmental self-identity is related to feelings of moral obligation to act pro-environmentally, which in turn affects pro-environmental actions.

With social media being a ubiquitous presence in modern life it has been argued that social media ap-

proaches are more effective than conventional communication channels and that they have the potential to replicate face-to-face interactions [47]. This builds on the idea that social networks have an influence in encouraging resource conservation [2]. Young et al. [146] empirically test whether social media, specifically Facebook, can be used to change behaviour. Their study aimed to reduce food waste in the UK by behavioural change. They find that social media cannot replicate the social influence impact of face-to-face interventions, which is contrary to findings elsewhere [73, 118]. In general, they suggest that social media should be classified as an information intervention, and not a substitute to face-to-face interaction. On a related vein a behaviour change study using smart phone apps concluded that smart phones apps provide a promising alternative for feedback delivery [81], though engagement with a specific phone app may be subject to selection biases.

The greater share of research focusing on changing people's environmental behaviours on environmental issues typically consider waste management and energy topics among households. Focusing on areas where the impact is potentially greatest would be more a efficient use of resources [43]. In the case of water quality and sustainability of aquatic ecosystems the area where behavioural change could potentially have the greatest impact is within the agriculture sector. Lokhorst et al. [77] is a specific case study focusing on the agriculture sector, examining the behaviour change potential of the EEA interventions on environmental quality of farmlands. Their study is resolute in its findings; the combination of tailored information and the making of public commitments was especially effective in eliciting behaviour change. What is also striking about the EEA intervention is that the study participants were asked to participate in only one public meeting during the course of the EEA intervention, which is a modest burden both for participants and the research team. A critical element of that one meeting is that participants made a public commitment to pursue conservation practices, which Lokhorst et al. [77] conclude is a critical element of the overall success of their behaviour change study. They note that conservation practices themselves do not influence farmers' attitudes, behaviour or understanding of biodiversity, even where agri-environmental subsidies fund specific bio-diversity friendly activities [15, 55]. Even given their success in achieving behavioural change they note that they were not successful in eliciting attitude change, with success in the former attributed to the public commitment, while lack of success in the latter attributed the fact that participants publicly committed themselves only once.

4.3.2. Social Influence

Social influence treatments were predominantly used in treatment-control applications and most results report positive behavioural responses to SI stimuli. Treatments of SI are very flexible and can be used to stimulate specific pro-environmental behaviours, e.g. switch off devices or idling cars [87], or for broader purposes, e.g. raising awareness of climate change. Several studies indicates that SI is more effective than EAA [e.g, 11, 48]. Brick et al. [11] report that SI treatments perform better than EAA treatments. This result is consistent with a meta-analysis by Abrahamse and Steg [2], which evaluates the effect of SI in treatment-control studies. However, SI effectiveness is largely based on the type of treatment chosen. Similar to EAA findings, face to face approaches are considered to be especially effective, for example, Block Leaders and public commitments. Hopper and Nielsen [56], Burn [12] and Cobern et al. [19] find that using a Block Leader provided the largest effect on recycling behaviour across all treatments. Cobern et al. [19] find that Block Leader effects are maintained after 1 year. With respect to public commitment, Burn and Oskamp [13] find that commitment increased recycling by 18 percent, compared to an EAA treatment that produced a 15 percent increase in recycling.

Results about social feedback are mixed. Despite effectiveness being reported in some studies [127], the

average effect size of social feedback is small to negligible [2, 32]. Some studies suggest that larger SI effects were found when the control group is very similar to the treated group in terms of socio-demographics [48]. During the implementation of a SI treatment, people's sense of belonging to a group is very important and therefore the reference group should be chosen carefully [9].

Abrahamse and Steg [2] emphasise that little is known about the long-term durability of SI studies, as follow-up assessments are only seldom considered. Some studies report sustained effect after just a short period of 3-8 weeks [70, 95, 113], whereas Winett et al. [140] find that the effect is lost after one year. Long-term effects are difficult to evaluate and more research is necessary for conclusive findings. Repeated treatments over time is a strategy to facilitate sustained behaviour, although that is often impractical. Low cost measures such as comparative feedback and social norm statements are appropriate actions for repetition over time.

4.3.3. Outreach and Relationship Building

ORB interventions have the largest share of success across treatments examined. This result is not surprising because ORBs combine positive relationship building with the benefits of other treatments, such as education and social influence, as information or feedback is often provided. In the literature screened ORBs are predominantly used with before-after approaches, possibly due to the fact that they are implemented at community level and require the involvement of all members. Therefore, a control group with no treatment assigned is not easily available. The Cloughjordan ecovillage in Ireland is an exemplary case of ORB involving the entire community [36]. Established in 1999 and supported by the European Union, the Irish government and community members, this village is a place where people live and work in an eco-friendly way. Energy is generated from renewable sources, land use and waste disposal are managed according to sustainable principles and the entire community is involved in decision-making. Most activities are carried out by volunteers, therefore the sense of feeling part of the community is an important condition to achieve success. The project took several years to be fully operational. Another example of ORB at community level, although not equally successful, is "Energy Champions", organised by Stockbridge village in the UK [6]. The project employed a mix of tools and recruited residents to engage in peer-to-peer information exchanges and seek ways to promote energy efficiency. A crucial aspect of the project was training for residents to allow effective energy savings communication. Despite large effort expended in ORB treatments, participation was low and resulted with a limited impact on the village. These case studies give at least two interesting insights. First, the amount of time, resources and community liaisons necessary for a successful ORB is very high and are more likely to be effective where the sense of belonging to the community is strong. Second, ORBs are performance-oriented and try to respond to concrete needs, the scientific aspect is not as important, which partly explains the lack of control groups and rigorous measurement of the impact in many case studies.

The main ORB tools are focus groups, training sessions and public meetings and success is often assessed qualitatively [6, 33]. In some cases, the qualitative success measure of ORB interventions is the level of participation and engagement of participants [e.g., 23] during public meetings and how participation increases over time, which may affect the ORB success rate. These types of ORBs are not directly comparable with quantitative studies, where an outcome variable (e.g. recycling rate or energy use) rather than an input is precisely measured. Broad participation in ORB events does not imply a strong impact on environmental behaviours.

4.3.4. Nudges

Nudge treatments are often successful, which partly explains the gain in popularity. Treatment-control studies are the standard framework for nudge evaluation and quantitative statistical techniques are adopted for performance assessment. There are several cases where nudges report the largest behavioural change impact. For example, Cosic et al. [20] report that large levels of recycling was achieved when recycling bins were made bigger and more visible compared to general waste. The experiment undertaken by Poortinga and Whitaker [104] find a large share of students choosing reusable rather than single use cups only when they were provided for free. Hsu et al. [59] report a positive effect on water saving when Taiwanese households were nudged towards a more efficient use of water resources. These studies indicate that altering the choice architecture of respondents has a positive impact on pro-environmental behaviours.

Depending on the behaviour change application and policy context, nudges can be resource intensive. In this respect, a costly intervention, as outlined by Poortinga and Whitaker [104], is not likely to be permanent and the pro-environmental behaviour may change when the measure is no longer in place. Other waste-related interventions, such as recycling, can be easily sustained with small changes in the choice architecture, e.g. changing number, location and size of recycling bins to encourage waste disposal. In some cases it is very hard to act on the choice architecture, therefore nudges become infeasible. For example, switching off computer monitors after work is an important energy efficiency measure [87, 131] but it is difficult to design a change in the choice architecture, i.e. where people sit at their computer, that can nudge a change in behaviour. In such cases EAA and SI interventions, such as posters with reminders to switch off monitors, may be more appropriate.

The literature on green incentives has raised ethical questions on the use of nudges, because they are not grounded in welfare theory and they sometimes affect behaviours in non-paternalistic and manipulative ways [51, 52, 96]. These topics have been thoroughly studied by Schubert [112], who proposed a set of guidelines to reconcile ethics and nudges. First they propose a justification for environmental nudges grounded on the urgency of solving problems such as climate change. Second, they suggest that nudges should complement and not substitute other traditional measures [30, 39] because, as outlined by Gowdy [49], environmental transitions require institutional changes and not merely individual behaviour change. Third, nudges should be transparent to avoid manipulations of individual choices, e.g. changes in the choice architecture should make the 'green' choice easier over the others but not reduce the set of available choices.

4.3.5. Incentives

The policy area where incentives are used are mostly waste, energy and water and are often effective compared to control groups and other types of treatment [16, 46, 105]. This is consistent with other meta-analytic studies that found significant effects of incentives for energy and waste sectors [27, 57]. The standard approach to employ incentives was the treatment-control study and statistical techniques such as Anova and regressions were frequent methods of analysis. The relative efficacy of monetary and non-monetary measures is still subject to debate with a range of empirical findings, as illustrated in the examples that follow. Rajapaksa et al. [105] depicts a study were monetary and non-monetary incentives are compared to encourage domestic water conservation in Australia. Results indicate that all treatments positively affect water conservation but non-monetary incentives yielded a larger impact. Another study on household water use found no differences across incentive treatments in Singapore[46]. A positive effect of monetary incentives for behaviour change in recycling and transport was found by Xu et al. [142] and Shove and Walker [119], respectively. A negative result on was detected by Poortinga and Whitaker [104], who investigate students' attitudes to using reusable coffee cups and found that price discounts did not increase reusable cup

use versus single-use cups. With respect to energy efficiency Yeomans and Herberich [143] find a small but statistically significant positive effect from the use of a monetary incentive.

The literature is divided on the merits of incentives because they do not stimulate individuals' awareness towards environmental problems but give concrete awards to people who adopt the desired actions [82]. Incentives impact on people's welfare and not on their attitudes towards environmental problems. In some cases individuals have an intrinsic willingness to sustain a pro-environmental behaviour and incentives represent an additional motivation to initiate behavioural changes [97]. However, incentives may decrease people's intrinsic motivation to adopt a pro-environmental behaviour [26], though there is evidence of the contrary also [35]. Another debated topic is whether incentives are capable of providing sustained behaviour change over time. Prior research has stressed the differences between initial and sustained behaviour and reviews in the health sector suggest that, while there is evidence that incentives contribute to the initial behaviour change, it is also likely that behaviours are not maintained when incentives are removed [14, 91]. The meta-analysis of environmental incentive studies provided by Maki et al. [82] conclude that behaviours can be sustained over time and that cash and non-cash incentives have different effects based on the type of behaviour. Incentives may be particularly appealing for local authorities, because pro-environmental behaviours are related to their supply of public services, e.g. recycling or energy supply, subject to budget.

5. Discussion

Improving environmental quality and natural resource abundance can be achieved by changing unsustainable behaviours. The assembled database of behavioural change studies provides insight on the efficacy of different behaviour change treatments. The vast majority of peer-reviewed papers presents experimental studies where behaviour change treatments are compared with a control group. The comparison of groups that only differ by the received treatment is helpful to precisely identify treatment effects and establish measures of behaviour change success. In before-after studies it is difficult to disentangle treatment effects from pre-existing trends because other time varying variables may affect the results [100].

The analysis of treatment impact, success rate and area of application suggests that there is no evidence that one approach should be preferred over the others by default. The success of a treatment largely depends on the organisation of the work, as some studies report lack of coordination or ineffective monitoring as one of the main sources of failure [93]. The treatment choice should be based on specific objectives and available resources. It is also important to distinguish between two phases of behavioural change, when the effectiveness of treatment types is different. The first phase occurs when behavioural change programmes initiate and individuals start behaving pro-environmentally, which is the focus of most studies. The second phase is the sustained pro-environmental behaviours over time, for which scientific evidence is much smaller because long-term effects are difficult to evaluate.

EAA and SI interventions were relatively common across studies. To some extent EAA is a component of all other treatments because some information is always provided. The literature indicates that in some cases the impact of information-only treatments on environmental behaviours is small and often lower than the impact of other treatments. As proposed by Rothschild [109], EAA is more effective when individuals have voluntary and pre-existing motivations to engage in pro-environmental behaviours and lack some important information to initiate behavioural changes. Under these conditions EAA is useful to initiate

specific behavioural change and also for more general purposes of awareness raising.

SI interventions were more effective than EAA in several studies. The easy implementation and the small cost of most treatments make the use of SI particularly appealing for *ex-ante* evaluations of viable behaviour change approaches, when several treatments are compared. An interesting consideration is that the wide range of SI and EAA treatments could be used in combination to stimulate behaviour change at different stages. For example, a more expensive solution using Block Leaders may be implemented in the first stage of the experiment to stimulate initial pro-environment behavioural changes, while social feedback or social marketing communications could aim for the sustained behaviour over time. This multi-stage approach may be an interesting avenue of future research, as most SI studies at present use single observations of one treatment.

Despite the effectiveness of ORB interventions they are less commonly used. ORBs are resource intensive and usually try to raise awareness on multiple environmental issues, so that participants can take several different pro-environmental actions into their daily life [33, 130]. For this reason, ORBs appear particularly effective for topics of general interest, such as climate change or sustainable lifestyles, and usually are not targeted at specific behaviours, where EAA or SI treatments are more appropriate.

With respect to incentives, Maki et al. [82] suggest that they can be employed to initiate behaviour changes. However, there is no conclusive evidence that incentives significantly outperform other behaviour change approaches and more research is necessary for their wider support in behaviour change activities. Being on average more expensive than either SI or EAA, it is difficult to make a case why incentives should be preferred over cheaper and possibly equally effective alternatives on large scale behaviour change projects. As Maki et al. [82] conclude, possibly the case for incentives is still confined to the research domain, as specific guidelines for their implementation is missing.

Nudges are useful tools for individual behavioural changes, assuming they follow ethical guidelines. However, their application is limited to situations in which the choice architecture can be effectively modified. For example, in-house energy efficiency cannot be nudged, as it would require structural interventions in the buildings. Alternatively, switching off computer monitors is also an example out of nudge applicability. In these situations EAA or SI interventions are more likely to be effective.

Additional to reviewing the effectiveness of successful methodologies and approaches, the analysis identifies some open questions on topics that are often overlooked. An important issue is the targeted behaviour to be tackled, because not all behaviours have the same impact on environmental quality. For example, Gardner and Stern [43] highlight that it is far more environmentally beneficial to change purchasing behaviours than encouraging reuse, and it is better to reduce car use compared to reusing plastic bags in stores. In most published papers, behaviour change applications start from the behaviour to change, not the environmental problem being tackled [122]. Therefore, it is not always clear whether findings represent the optimal solution. When environmental quality is at stake, behaviour change studies should consider the behaviour that causes the largest impact and take appropriate approaches to stimulate behaviour change. In essence focus resources on larger wins rather than the easier behaviours that many have only minimal impact on the ultimate objective. Several techniques have been developed for impact assessment, such as life-cycle assessment and input-output analysis, which are useful for a preliminary impact assessment [e.g. 68, 76, 90, 101, 125].

Another open question relates to the long term effects of behaviour change approaches because only a small number of studies include follow-up analyses. The review of SI studies by Abrahamse and Steg [2] suggests that in before-after applications the treatment effect often dissipates when the measure is no longer in place. However, the number of studies examining the issue is small and therefore it is difficult to draw definitive conclusions.

In some cases behaviour change actions are already in place without clear assessment protocols in place and what is not known is the extent to which these actions are successful or not. This may happen when a behaviour change project is created without a clear idea about performance measurement. The dedicated literature to answer this question with a specific focus on behaviour change models is scarce. Frondel and Schmidt [41] propose a Potential Outcome Model to evaluate environmental policies already being implemented, which can be easily extended to behaviour change programmes. An example of pro-environmental behaviour assessment with Potential Outcome Model framework is provided by Adan and Fuerst [4], who investigate the effect of energy efficiency measures on household energy consumption using a difference-in-difference approach.

5.1. Barriers

People face several barriers in changing environmental behaviours, some are personal barriers while others are organisational or institutional. Blake [8] argues that personal barriers can be categorised in three types: individual barriers, responsibility and practicality. Individual barriers refer to attitudes and temperament (e.g. laziness) and are particularly prominent in people with weak environmental concerns. Responsibility is where individuals do not engage in virtuous environmental behaviours because of a lack of trust, which leads to a belief that individual behaviours cannot influence the situation. The third barrier is practicality, which relates to how social and institutional impediments impact on behaviour regardless of individual attitudes (e.g. lack of time, money and information). Dolnicar and Hurlimann [31] draw similar conclusions reporting that cost, convenience and practicality are the main barriers to positive behaviours towards water conservation. The design and planning stage of a behavioural change project should be mindful of these barriers and anticipate potential sources of failure. McKenzie-Mohr and Schultz [87] show three successful behaviour change case studies in which the implementation of the approach was preceded by a detailed assessment and attenuation of barriers that could potentially threaten the outcome. They conclude that barrier assessment is a fundamental step in behaviour change implementation.

Table 3: Explicit mention of barriers in the review documents

Type of barrier	**Policy Context**	**Approach**	**Success**	**Authors**
Organisational	energy	social influence	No	Galvin [42]
Personal	energy	education and awareness	Yes	Jiang et al. [62]
Personal	waste	education and awareness	Yes	Tonglet et al. [129]
Organisational	energy	outreach/relation building	No	Axon et al. [6]
Organisational	sustainability	outreach/relation building	Yes	Espinosa and Walker [36]
Personal	waste	social influence	Yes	McKenzie-Mohr [86]
Personal	sustainability	outreach/relation building	No	Trier and Maiboroda [130]
Organisational	waste	nudge	Yes	Thomas et al. [126]
Organisational	sustainability	education and awareness	No	Mourik et al. [93]
Organisational	sustainability	education and awareness	No	Mourik et al. [93]

In many instances unsuccessful behaviour change projects are due to organisational problems, including ineffective monitoring of activities. In Table 3 we report the papers that explicitly cite personal or organisational barriers that have either threatened the success of a behavioural change project or led to its failure. In some cases barriers are related to the personal characteristics of the target group, for example, lack of awareness of consequences [62] or feeling that pro-environmental behaviours are inconvenient [129]. Organisational barriers include poor programme recruitment or participation, programme team turnover, among others [6, 93]. None of the studies cited in Table 3 assessed potential barriers prior to implementation nor used an experimental treatment and control approach, both of which may have improved study design and achieved improved treatment effects.

6. Recommendations for a behaviour change programme

This analysis suggests that more scientific evidence is necessary to fully understand the most suitable implementation of behaviour change projects. However, the body of research presented provides a number of good practices, which can be used as guidelines for practitioners in real world projects, with the report by LyndhurstBrook and WatchWaste [80] being particularly relevant.

Carefully select the behaviour to change. The ultimate goal of any behaviour change project is to achieve the largest positive impact on environmental quality. To that end, not all behaviours are equally important. Small improvements of key behaviours may be more beneficial than very large changes in secondary behaviours. Therefore, any research programme should first concentrate on behaviour selection. Behaviours should also be clearly defined, to avoid misinterpretation of actions to take.

Choose treatments based on type of behaviour objectives. All treatments are potentially successful if implemented in the right situation. The suitability of treatments is context-dependent and the most appropriate should be selected on the basis of the chosen behaviour and objectives.

Establish a control group. The comparison of groups that only differ by the received treatment is helpful to precisely identify treatment effects and establish measures of behaviour change success.

Start small. In most cases it is difficult to establish *a priori* the most suitable approach to behaviour change. A pre-test using small samples should be considered, organised as a treatment-control experiment in which a number of candidate treatments are assessed and compared. Good practice is to use randomly selected recruits rather than volunteers to avoid selection bias. Volunteers are likely to be people with a pre-existing interest on environmental issues and lead to results that are non-representative of the entire population.

Define treatments and allow replication. In the testing phase treatments should not overlap across subsamples and each subgroup should receive a set of unique instructions. Do not use treatments that cannot be replicated at large scale. Once the most suitable treatment is selected, the large scale implementation should exactly follow the pre-test procedure.

Define the measure of success and measurement methods. Define the outcome that you want to measure, i.e. the dependent variable(s). For example, if the ultimate goal of the project is to improve water quality, potential outcomes of interest are water quality metrics, possibly localised to the treatment area. In many instances, programme inputs are confused with outcomes. Examples of the former are programme expenditures, number of focus groups/participants/meetings, etc.. Outcomes are measures of change in

the environment, for example, improved water quality. It may also be useful for programme assessment to measure changes in behaviour, though changing behaviours may be insufficient to achieve the desired environmental outcome, particularly if the targeted behaviour is poorly selected. For full evaluation of the programme, or if there is a long lead time before environmental impacts are anticipated, also measuring behaviour change metrics may be useful. Measurement of change in behaviours may offer an early insight on whether the ultimate goals of the project might be achieved in the future. If the level of change in behaviour is negligible there should be no expectation of a subsequent causal improvement in the environment.

Record resource inputs. To fully evaluate a behaviour change programme, an expansive record of resource inputs should be maintained. Using such information it will be possible to quantify relative efficiency of treatments types, regional effects, threshold effects, among other factors. Ongoing data collection and analysis facilitates refinement in behaviour change programmes and improvement in outcome efficiencies.

Monitor the long run. While treatments may be temporary, pro-environmental behaviours should be sustained over time. Therefore, behavioural change projects should collect performance data regularly to assess policy impacts of the measures and provide new *stimuli* if necessary. Treatments in these follow up stages are not necessarily the same as treatments for initiating the behaviour. For example, low cost solutions such as information or social feedbacks at fixed time schedule may facilitate the sustained effect of initial treatments.

7. Conclusions

Human behaviour represents both the cause of and the solution to several of the environmental questions. In this paper 85 peer-reviewed and unpublished case studies that proposed behaviour change projects and methods were reviewed. Five types of approaches to behaviour change, namely education and awareness, social influence, relationship building, incentives and nudges, were identified and their effectiveness discussed across different policy areas. Scientific findings indicate that all treatments are somewhat effective but with different magnitude based on behaviour type and target population. There may be barriers to the implementation of behavioural changes, which in some cases are at individual level, for example unawareness of consequences. In other cases, barriers may be relative to project implementation, i.e. organisation problems. Anticipating both types of barriers increases the chances of success in the implementation of behaviour change projects. While the literature is relatively abundant with respect to initial pro-environmental behaviour change impacts, evidence about long term effects are scarce; it is therefore recommended to data collection is continued beyond the implementation period to identify situations in which pro-environmental behaviours are not sustained over time.

In the implementation of a project to encourage pro-environmental behaviours, the behaviour to change is central for the final environmental performance and should be carefully assessed. Given that the performance of various approaches is context-dependent, it is useful to undertake a small pre-test of several candidate treatments on a random sample, before large-scale implementation. Moreover, the desired output and the measurement of the success should be clearly defined.

It should be noted that human behaviour is just one of the several concurring causes to environmental degradation and it is misleading to overly emphasise the role of behaviour. While changing people's approach to the environment is important, attention should not be diverted away from the many socio-institutional factors that affect environmental quality. For instance, energy-efficient behaviours would be

not so important if all energy was produced from renewable sources. Individuals have no control over several of the factors affecting environmental problems. In this respect, governments are more influential and possess public policy tools to effectively tackle environmental problems and redirect human actions towards more sustainable paths.

Appendix A

Table 4: Database of Behaviour change studies

Authors	Policy Area	Behaviour	Type of Study
Crawford et al. [23]	climate change	Climate change Awareness	Treat.-Control
Estrada et al. [37]	climate change	Climate change Awareness	Before-After
Doyle and Davies [33]	energy	reduce energy use	Before-After
Galvin [42]	energy	energy efficiency	Before-After
Jiang et al. [62]	energy	many (energy use, waste)	Before-After
Axon et al. [6]	energy	reduce energy use	Before-After
Gregory-Smith et al. [50]	energy	reduce energy use	Treat.-Control
McKenzie-Mohr and Schultz [87]	energy	switch off computers	Treat.-Control
Carrico and Riemer [16]	energy	reduce energy use	Treat.-Control
Terrier and Marfaing [124]	energy	reuse towels	Treat.-Control
Yeomans and Herberich [143]	energy	inflate car tires	Treat.-Control
Abrahamse et al. [3]	energy	reduce energy use	Treat.-Control
Brandon and Lewis [10]	energy	reduce energy use	Before-After
Schall and Mohnen [111]	energy	eco-driving	Treat.-Control
Ma et al. [81]	energy	reduce energy use	Before-After
Goldstein et al. [48]	energy	reuse towels	Treat.-Control
DeWan et al. [28]	energy	use fuel efficient stoves	Before-After
Weenig and Midden [138]	energy	reduce energy use	Before-After
Loock et al. [78]	energy	reduce energy use	Treat.-Control
Leoniak and Cwalina [75]	energy	light switching	Treat.-Control
Wong-Parodi et al. [141]	energy	reduce energy use	Treat.-Control
van der Werff et al. [132]	energy	reduce energy use	Treat.-Control
Yun et al. [147]	energy	reduce energy use	Treat.-Control
Mourik et al. [93]	energy	reduce emissions at work	Before-After
Mourik et al. [93]	energy	increase energy efficiency	Before-After
Mourik et al. [93]	energy	increase energy efficiency	Before-After
Mourik et al. [93]	energy	reduce stand-by energy use	Before-After
Mourik et al. [93]	energy	100% renewables in 10 years	Before-After
Mourik et al. [93]	energy	reduce energy use	Before-After
Mourik et al. [93]	energy	reduce energy use	Before-After
Mourik et al. [93]	energy	reduce energy use	Before-After
Mi et al. [89]	energy	reduce energy use	Treat.-Control
Siero et al. [120]	energy	reduce energy use	Treat.-Control
Henkel et al. [54]	energy	energy efficiency	Treat.-Control
Lokhorst et al. [77]	farming	use of fertilisers	Treat.-Control
Peth et al. [102]	farming	reduce fertilisers	Treat.-Control
Andriamalala et al. [5]	fishing	sustainable fishing	Before-After
McKenzie-Mohr and Schultz [87]	fishing	release contaminated fish	Treat.-Control
Hargreaves [53]	sustainability	Many (energy use, waste)	Before-After
Trier and Maiboroda [130]	sustainability	lifestyle change	Before-After
Marks et al. [83]	sustainability	environmental awareness	Before-After

Table 4 – continued

Authors	Policy Area	Behaviour	Type of Study
Mourik et al. [93]	sustainability	reduce energy and water	Before-After
Mourik et al. [93]	sustainability	reduce energy and water	Before-After
McKenzie-Mohr and Schultz [87]	transport	idling engines	Treat.-Control
Shove and Walker [119]	transport	reduce private transport	Before-After
HSWD [60]	waste	increase recycling	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase recycling	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase recycling	Before-After
Changeworks [17]	waste	washable nappies	Before-After
LyndhurstBrook and WatchWaste [80]	waste	washable nappies	Before-After
Council [21]	waste	increase recycling	Before-After
St. Nicks Council [121]	waste	increase recycling	Before-After
Global Action Plan [45]	waste	increase recycling	Before-After
HRNP [58]	waste	washable nappies	Before-After
Kingston and Merton [65]	waste	washable nappies	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase composting	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase recycling	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase recycling	Before-After
LyndhurstBrook and WatchWaste [80]	waste	increase recycling	Before-After
Tonglet et al. [129]	waste	minimise waste	Before-After
Weber et al. [137]	waste	minimise waste	Before-After
McKenzie-Mohr [86]	waste	increase composting	Before-After
Whitmarsh and O'Neill [139]	waste	minimise waste	Before-After
Young et al. [145]	waste	minimise food waste	Treat.-Control
Thomas et al. [126]	waste	increase recycling	Before-After
Young et al. [146]	waste	minimise food waste	Treat.-Control
Timlett and Williams [128]	waste	increase recycling	Treat.-Control
Dupré and Meineri [34]	waste	increase recycling	Treat.-Control
Lakhan [71]	waste	increase recycling	Before-After
Schultz [113]	waste	increase recycling	Treat.-Control
McCaul and Kopp [85]	waste	increase recycling	Treat.-Control
Xu et al. [142]	waste	increase recycling	Treat.-Control
Dorn and Stöckli [32]	waste	reuse takeaway boxes	Treat.-Control
Poortinga and Whitaker [104]	waste	increase reusable cups	Treat.-Control
Cosic et al. [20]	waste	recycling	Treat.-Control
Council [22]	water	increase composting	Before-After
Schultz et al. [115]	water	water consumption	Treat.-Control
Kurz et al. [70]	water	reduce water use	Treat.-Control
Hsu et al. [59]	water	minimise water use	Treat.-Control
Lede et al. [74]	water	reduce water use	Treat.-Control
Goette et al. [46]	water	reduce water use	Treat.-Control
Rajapaksa et al. [105]	water	reduce water use	Treat.-Control
Dickerson et al. [29]	water	reduce water use	Treat.-Control
Brick et al. [11]	water	reduce water use	Treat.-Control

Table 4 – continued

Authors	Policy Area	Behaviour	Type of Study
Salazar et al. [110]	wildlife	reduce demand for pet parrots	Before-After

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