





NOUS REPORT

  *Review of Climate Change Communication and Behavioural Intervention Strategies to*
  *Maximise Behavioural Impact*



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Geneva, June 2022



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Preliminary remark: A french version of this document is available, entitled: Revue des stratégies de communication sur le changement climatique et d' intervention comportementale visant à maximiser l'impact sur les comportement

Executive summary

Addressing the climate change crisis requires far-reaching behavioural changes in regard to carbon-intensive lifestyles. But how to facilitate the required behavioural changes? What is the best way to communicate climate change such that behavioural change follows suit? And what types of behavioural interventions are the most effective to facilitate behavioural change?

Based on the state-of-the-art literature we reviewed, the short answer to these questions is: It is complicated. More to the point, there seems to be no golden standard, no one-size-fits-all solution, and no one type of intervention that works best across all people, behavioural domains, and contexts. Instead, as in other contexts of behaviour change communication such as health (obesity, COVID-19, addiction) or social inequality (e.g., sexism, ageism, racism), climate change communication (CCC) benefits from reflecting on the complexities inherent to all communication processes aiming at changing behaviours by tailoring messages in accordance with given audiences and the specific behaviours that need changing.

The circular graph below summarises our own approach to CCC (see Figure 1). We start by discussing how climate change is an inherently **abstract, novel, and psychologically distant** phenomenon (see [Section 2](#)). We show that because of these attributes, communicating climate change to facilitate behaviour change faces multiple **emotional, social** and **psychological** barriers (see [Section 3](#)), in addition to **behavioural barriers** (see [Section 4](#)). Key barriers include social norms and political distance that perpetuate high-carbon attitudes and behaviours, biased risk perceptions failing to sense the urgency of the situation, low control perceptions discouraging action as well as missing emotional engagement as key motivators for taking action (see more in [Section 5](#)).

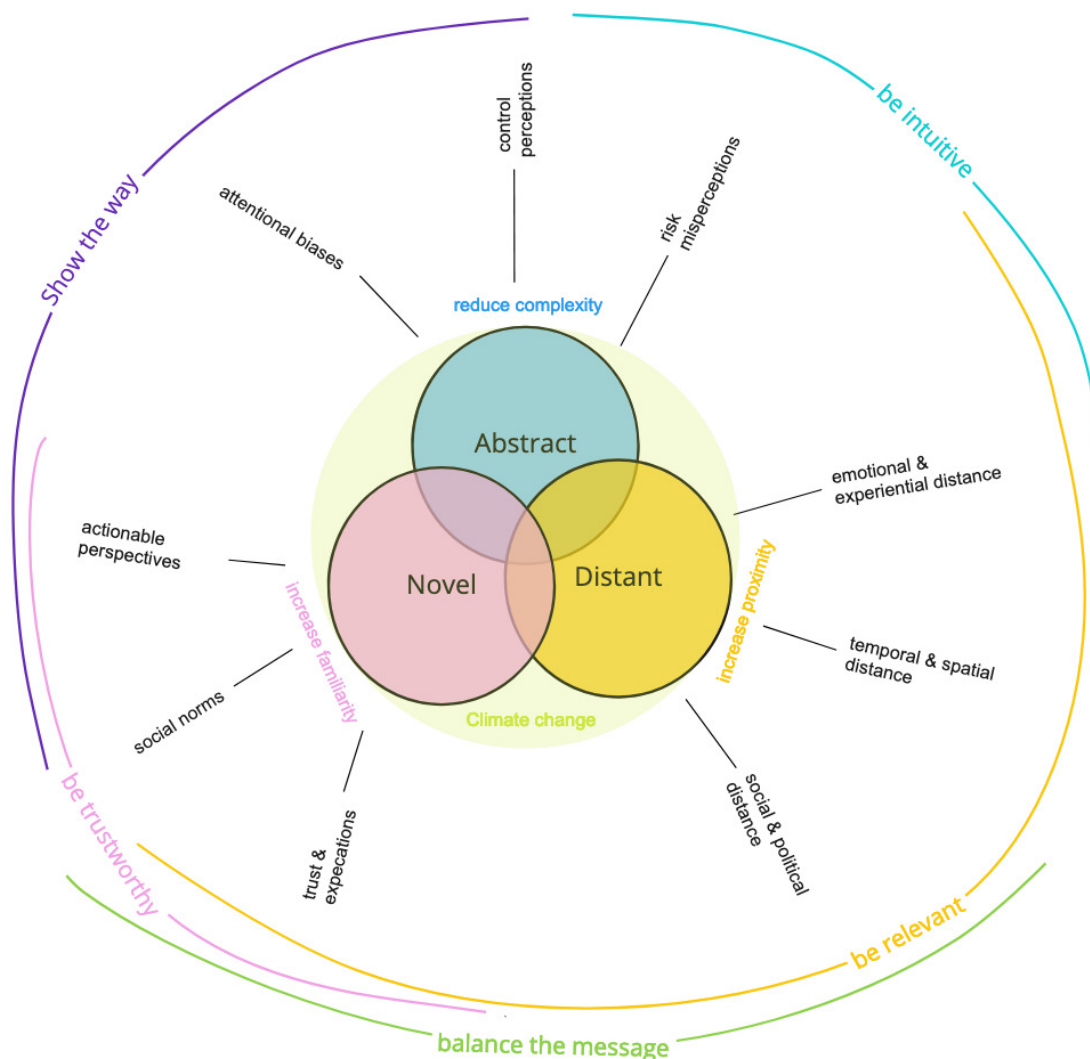


Figure 1: Five general principles for CCC to overcome the complexity of climate change (abstractness, novelty, and distance) and the consequent psychological and social barriers (e.g. low-risk perceptions).

In turn, effectively **communicating climate change** must address the abstractness, novelty, and psychological distance of climate change by reducing the complexity inherent to climate change. Our review of existing CCC guidelines suggests multiple strategies as to how to reduce complexity and increase familiarity and proximity to climate change by a) **making CC more relevant** to a given audience, b) **being more intuitive**, c) **being trustworthy**, d) **providing actionable insights**, and e) **balancing the message**. We provide concrete and practical examples of how to apply these guidelines in CCC and how these guidelines can help communicators address the psychological and behavioural barriers involved in CCC (in

[Section 6](#)). Additionally, our meta-analyses review identified several **behavioural interventions** showing effectiveness in creating positive behaviour change. The reviewed evidence indicates that **nudges, environmental alterations, monetary incentives, social norms, feedback,** and **commitment** can be effective strategies in facilitating climate change mitigation behaviours. Importantly, however, the effectiveness of these behavioural interventions is dependent on which specific behaviour is targeted (see [Section 7](#)). We illustrate concrete examples based on the [AWorld](#) application, a sustainable behaviour tracking and monitoring application provided by the United Nations, and highlight how some of these behavioural interventions (e.g., Social norms, Commitment, Incentives, Gamification) are complementary tools to CCC tools (e.g., Education, Persuasion, Framing, Information, Appeals). In our last Section ([8](#)), we discuss some limitations as well as the additional efforts needed to improve the state of the art of CCC and behavioural interventions in the context of climate change.

Two recurring findings are important to highlight here at the beginning of our report: Firstly, recent studies show that people show great misunderstandings about the impact that their climate change mitigation behaviours actually have (see [Section 3](#)). As a consequence, climate change communicators are well-**advised to raise awareness about the different levels of effectiveness for different types of behaviours** to maximise their impact. Secondly, and relatedly to the first point, our literature review and synthesis showed that climate change communication needs to **strategically focus on high-impact behaviour change** (e.g., less flying, car-driving, meat consumption) in order to maximise its impact. We discuss these two findings in the last Section of our report (see [Section 8](#)).

To summarise, in this academic synthesis report, we draw on the latest scientific and academic literature on climate change communication guidelines as well as on experimental psychological and behavioural intervention studies to present the state of the art of available tools and strategies to communicate climate change in order to facilitate individual behaviour change. **Our results show that CCC can be designed according to five principles to maximise its impacts but that it cannot ensure systematic behavioural change. On the other hand, several behavioural interventions show effectiveness to facilitate**

behaviour change to some extent and should be used in conjunction with CCC strategies.

1. Introduction

The latest report from the Intergovernmental Panel on Climate Change (IPCC, 2022) notes that 3.5 billion people, roughly 40 percent of humanity, are “highly vulnerable” to the impacts of climate change [1]. Accelerating climate change will harm human health [2], disrupt economies [3], increase inequality [4], increase hunger [5], drive mass migrations [6], push entire ecosystems to a point of no return (e.g., biodiversity loss) [7], and make some parts of the world uninhabitable for humans [8].

Yet, despite three decades of political efforts and a wealth of research, global carbon dioxide emissions, the main cause of climate change, have continued to rise and are 60% higher today than they were in 1990 [9].

Besides significant structural changes on the supply-side (e.g., transition from fossil fuels to renewable and alternative energy sources, socio-economic transformations), addressing climate change requires far-reaching behavioural changes in carbon-intensive lifestyles on the demand-side of the equation [9]. Household consumption accounts for 72% of global greenhouse gas emissions, which makes the transition to more sustainable lifestyles an essential part of tackling climate change, especially in high-income countries of the global north. There is a significant and largely untapped potential for reducing demand for energy and resources through behaviour changes. Hence, effectively communicating the necessity and urgency of behavioural change, that is adopting less carbon-intensive lifestyles, is of paramount interest to public and private organisations in order to mitigate the negative consequences laid out in the latest IPCC report.

Behaviour change via climate change communication and behavioural interventions

In this report, we focus on two broad toolboxes that can aid in facilitating the required behavioural changes on the demand-side: climate change communication and behavioural interventions.

1. Introduction

Climate change communication (CCC) can be described as the process of transmitting information in order to educate, warn, persuade, and mobilise with the goal of helping people to mitigate and adapt to climate change. As an academic field, climate change communication seeks to understand these transmission processes, develop and test scientific theories, and identify more effective communication and intervention strategies to address climate change. Climate change communication experts focus on strategies and tools that can be employed in public communication settings via traditional channels such as television, radio, social media, and newspapers and are accessible to public and private institutions. Research on CCC mostly focuses on changing attitudes and intentions, rather than directly changing actual behaviours.

Behavioural interventions (BIs) also focus on helping people to mitigate and adapt to climate change. However, in contrast to climate change communication experts, behavioural scientists employ so-called behavioural interventions which can involve a broader range of techniques such as monetary incentives and environmental alterations which do not necessarily fit into a more narrow definition of climate change communication. Behavioural interventions can be applied in the form of policies (e.g., default options) as well as information campaigns and represent complementary strategies for achieving behaviour change. As the term *behavioural intervention* already suggests, the focus is on changing actual behaviours rather than attitudes.

Over the last twenty years, climate change communication and behavioural intervention scholars have developed several guidelines to help individuals, organisations, and institutions educate the public about climate change [10–14]. Moreover, hundreds of scientific studies have been conducted, testing various climate change communication and behavioural intervention strategies in order to facilitate behavioural change.

This academic synthesis report draws on the latest scientific and academic literature on climate change communication guidelines and draws on experimental psychological and behavioural intervention studies to present the state of the art of available tools and strategies to communicate climate change in order to facilitate individual behaviour change.

Overview

We start by explaining the three key factors associated with climate change that make behaviour change particularly challenging (*Novelty, Abstractness, Distance*) ([Section 2](#)). In [Section 3](#), we present our theoretical model of climate change communication and break it down into its four main components (*Sender, Message, Receiver, and Behaviour Change*). Then, we briefly introduce behavioural intervention techniques aimed at behaviour change in the context of climate change mitigation and sustainability ([Section 4](#)). This is followed by presenting the scientific literature concerned with climate change communication and the psychological and behavioural factors that scientists have thus far identified as barriers to effective climate change communication ([Section 5](#)). In the following [Section \(6\)](#), we summarise some of the more prominent climate change communication guidelines which draw on existing research to provide practical tips for individuals, organisations, and institutions. [ActNow](#), a CCC campaign for individual action from the United Nations, will be used to illustrate these recommendations with concrete examples. The following [Section \(7\)](#) of this report presents our own systematic review of scientific studies on climate change/sustainability behavioural interventions designed to facilitate behaviour change. The last [Section \(8\)](#) of this report summarises and discusses our findings.

2. Climate change communication from a psychological & behavioural perspective

Despite thirty years of political efforts and a wealth of research on the causes and consequences of climate change, why haven't we made any significant progress yet? From a psychological and behavioural science perspective, the leading cause of this lack of progress stems from climate change being a highly complex phenomenon itself. This complexity can be summarised by three overarching attributes inherent to climate change (see [Figure 2](#)).

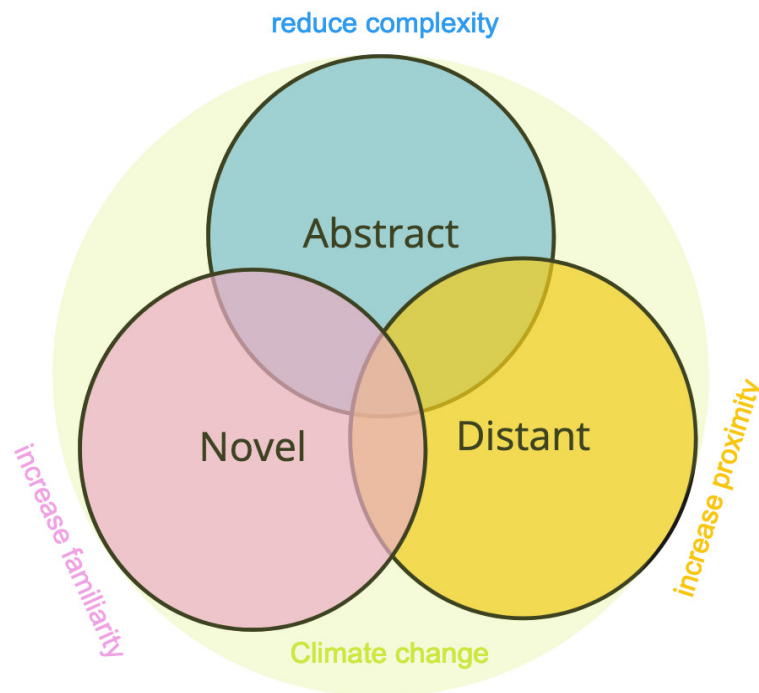


Figure 2: Climate change is abstract, novel, and distant, requiring CCC to reduce complexity, and increase familiarity and proximity

Abstract

Climate change (CC) is a highly **abstract** phenomenon that is not intuitive or easy to comprehend. This is notably due to its systemic nature which entails that several components of a system are interacting with each other [15]. Similarly, the climate is a complex and dynamic system arising from multiple biological and climatic processes, which are also linked to - and significantly influenced by - human activities. Thus, CC requires deliberate cognitive processing to be satisfyingly understood. As with other abstract phenomena, communicating climate change thus faces many **cognitive barriers** (see [Section 5](#)) which can significantly hinder communication efforts. The complexity is present in each step of communicating climate change: its causes and consequences as well as communicating the available solutions and required behavioural changes. One of the main challenges of facilitating behaviour change thus lies in reducing the inherent abstractness of CC (see later CCC principles in [Section 6: Make it intuitive, relevant, and balanced](#)) while still motivating to facilitate behaviour change.

Novel

Climate change is a *novel* phenomenon. While the existence of climate change has been known in academic circles for over half a century approximately, CC in the public mind is relatively new (30 years or less). As a consequence, many societies around the world lack the required **social norms** and **expectations** to address climate change in their everyday life. This lack of social normativity is partly explained by a lack of knowledge (*how to address climate change*) but is equally rooted in a lack of institutional and educational policies which would train a society as a whole to acknowledge and care about climate change such that climate change mitigation behaviours (e.g., reducing one's own carbon footprint) would become the social norm rather than the exception (see more in [Section 5](#)). The lack of political consensus and the resulting polarisation of the CC topic also partly explains why climate change mitigation behaviours are not yet largely part of the social norm. The required attitudinal and behavioural changes thus have the potential to create a normative conflict of interest (conflicting norms and values) and therefore, CCC and behavioural interventions need to consider finding ways to increase the familiarity with behaviours that are urgently needed to address climate change. Against this background, information on the most effective ways of reducing one's carbon footprint needs to be provided by continuously communicating actionable behaviours (e.g., flying and driving less, consuming less meat, buying energy-efficient appliances, etc.) and making these behaviours the new normal.

Psychologically distant

Climate change is a **psychologically distant** phenomenon. Psychological distance can be defined as the extent to which individuals perceive climate change as an important and concerning phenomenon that requires changing behaviours. Psychological distance can be rooted in several different basic human needs and cognitive and affective processing mechanisms. For instance, humans generally care more about things that directly affect themselves, their families, or communities in the present. In contrast to immediate needs, for decades, CCC has portrayed CC as something that will only occur in the distant future and in distant geographies, thus creating a **temporal and spatial distance** to the issue. To address the need for creating concern, CCC thus needs to make CC relevant to a given audience by

2. Climate change communication from a psychological and behavioural perspective

highlighting how CC affects them personally or their communities in the present (see principle [make CC relevant](#)). Another source of psychological distance, [social and political distance](#), is rooted in the polarised nature of climate change discourse. All around the world, people show different levels of concern and care, depending on their geographical locations, values, mental models, and political affiliations. Thus, CCC needs to take into account these specific values, mental models, and political alliances of different audiences to reduce psychological distance. Finally, another root of psychological distance, [experiential and emotional distance](#), is due to CC not representing a tangible, experiential issue. For many people, particularly for people in the global north, the consequences of CC are not (yet) directly experienced (for example by droughts, floods, wildfires, food shortages, etc.). Studies on behaviour change show that [emotions](#) can be a powerful motivator in behaviour change. Thus, CCC is well advised to consider reducing psychological distance by leveraging emotions as motivating factors. We will discuss more examples in the following sections.

3. Climate Change Communication model

What is climate change communication (CCC)?

Box 1: Definition and History of CCC

“Climate change communication (CCC) can be described as the process of transmitting information in order to educate, warn, persuade, and mobilise with the goal of helping people to mitigate and adapt to climate change. Early scholars described a simple transmission model of communication, comprised of a messenger, who transmits a message, through particular channels, to specific audiences. This simple model is still commonly used, but inherently describes a one-way process and too often assumes a passive audience who simply receives the information conveyed by the message.

More recently, scholars have recognized that this transmission model is often too simplistic. In many situations, there are a variety of messengers, who craft and transmit different and sometimes opposing messages, through an ever-growing number and complexity of channels, to diverse audiences who have their own pre-existing beliefs, attitudes and values, and who actively interpret and construct their own meanings from the messages they receive, which they, in turn, communicate through their own networks. Thus communication occurs within a rich, highly complex, and dynamic system of individuals, organisations, and institutions, with sometimes widely divergent knowledge, politics, and cultures. And it is through these dynamic processes that societies develop climate change awareness, (mis)understanding, concern, and action.” (YPCCC)¹

As the above-mentioned definition by the Yale Center for Climate Change Communication Program (YCCCP) indicates, climate change communication is a highly complex process. To better illustrate this complexity, we can break CCC down into its four main constituents, as depicted in Figure 3.

¹ Yale Program on Climate Change Communication, definition retrieved from <https://climatecommunication.yale.edu/about/what-is-climate-change-communication/>

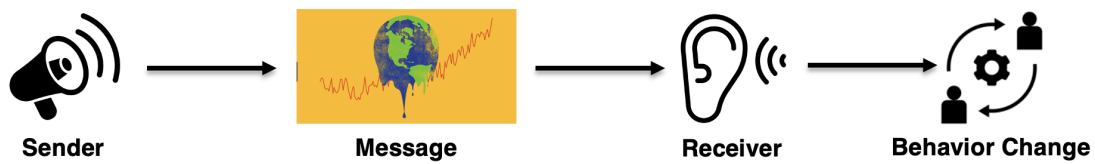


Figure 3: Climate change communication model

Sender

The first component of our CCC model, the **Sender** of the message, introduces some important complexity to CCC known as *source influence*. The *Sender* can be, for example, an individual person, an institution, a company, a political entity, a cultural figure, or a social media celebrity (e.g., influencers). Different senders will resonate differently with an audience depending on the specific composition of a given audience. For example, considering that climate change is a highly politicised topic, choosing a *Sender* who is politically more aligned with a given audience (an SVP political candidate speaking to a mainly SVP voting audience) can increase the effectiveness of CCC by leveraging shared social and political identity between the *Sender* and the audiences through trust and familiarity. Another example is to consider personalities that are trusted by large segments of societies more broadly, such as scientists. In Section [6](#) we will provide more concrete examples of how the *Sender* can make a message more *trustworthy* and *relevant* to the audience.

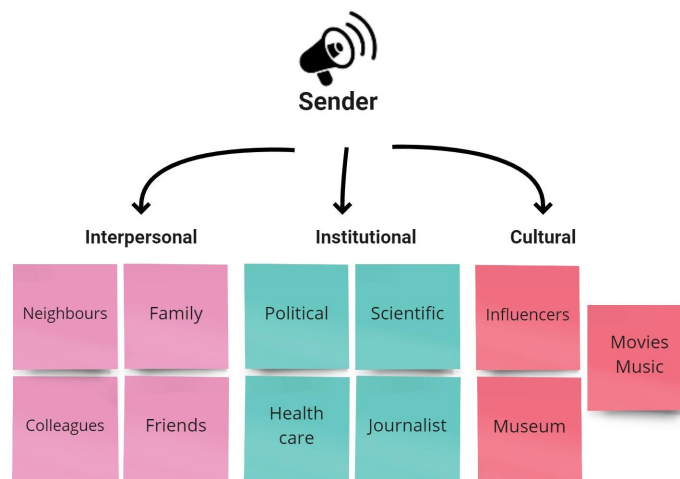


Figure 4: The type of senders and social contexts in climate change communication

It is not always possible, however, to create a perfect match between a given audience and a Sender, thus, while considering the different effects a particular Sender might have on a given audience is worthwhile, other ways of increasing the effects of CCC are necessary and available.

Message

The second component of our CCC model, the [Message](#), is perhaps the most widely researched component of CCC. In short, the message can be any type of information transmitted via audio-visual means using a variety of transmission media (e.g., newspapers, social media, television, leaflets, radio, etc.). As we will discuss in more detail in our summary, the Message component is perhaps the most versatile element of CCC. CC has far-reaching consequences for all life on earth and as such, its causes, consequences, and solutions can be discussed in a wide range of framings, nuances, and intensities. While earlier CCC has mostly communicated CC as an environmental issue affecting nature and animals, today, CCC equally highlights the social, economic, health, and moral consequences of CC as well. Framing CCC in different ways can have differing effects on how CC is perceived and whether the perceivers change their behaviour accordingly. Our literature search identified at least 3 broad categories of communication strategies that have been analysed in regard to facilitating positive attitudes change.

3. Climate change communication model

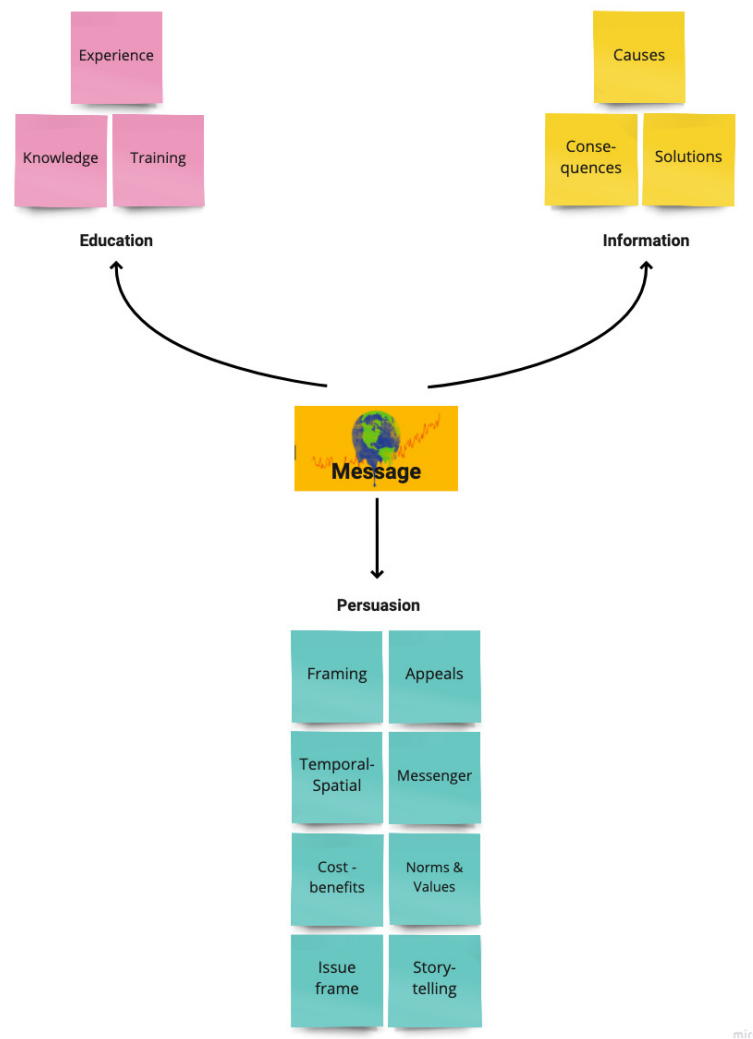


Figure 5: Strategies available to design the Message component in the climate change communication model

Table 1: Climate change communication strategies for behaviour change

Intervention type	Description
Information	This communication strategy consists of providing individuals with simple information on climate change or sustainability (causes and consequences) and detailed behavioural mitigation strategies. Information communication can range from simple messages conveying information on the causes and consequences of or general statistics about climate change.

3. Climate change communication model

Education	Education refers to a set of climate change communication strategies that go beyond simple information provision but also include training, experience, and long-term engagement with climate change and the necessary behavioural changes. Typically, educational programs are realised in institutional settings (schools, organisations, institutions).
Persuasion: Framing	Framing is a specific <i>persuasive</i> communication strategy that covers a broad range of intervention techniques. For example, framing strategies can be conceptualised as forms of persuasive messaging and include requests, pleas, and appeals to change behaviour based on values of humanity, cooperation, and social responsibility (see below). Another example of framing refers to so-called issue-framing. Issue framings contextualise climate change as either environmental, economic, health, or security issues. Framing can furthermore consider different aspects of the Receiver, such as their mental models, values, norms, and political affiliations, and tailor the message such that it is more in line with a given audience. Framing can moreover refer to communicating climate change via storytelling or scientific mode, highlighting the negative consequences or positive actionable dimensions (valence, loss-gain frames, temporal-spatial distance) and many other tactics.
Persuasion: Appeals	Appeals constitute a second group of persuasive climate change communication techniques. Appeals are various persuasive messaging techniques that can be delivered in the form of requests, pleas, and appeals to change behaviour, referring for example to values of humanity, cooperation, and social responsibility. Persuasive appeals can also focus on matching a given audience with a socio-politically aligned sender thus establishing trust. Another powerful way of appealing to a given audience is making climate change communication more persuasive via storytelling approaches instead of pure scientific communication styles.

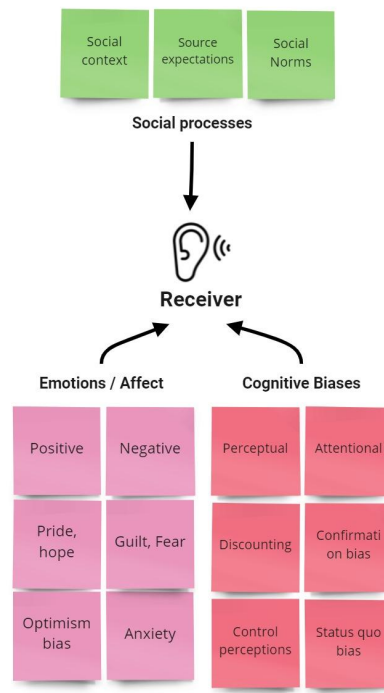
As we have mentioned in the introduction, the absolute majority of CCC research focuses on attitude and intention change and not on actual behaviour change. However, attitudes and intentions are relevant factors that themselves inform and precede behaviour change. We will provide more detailed information on CCC techniques such as information, education, persuasion, framing, and appeals further below after introducing the cognitive barriers of CCC.

Receiver

The third component of our CCC model, the [Receiver](#), refers to the individual or group audience to whom the message is addressed to. As we have briefly explained in the [definition](#) of CCC ([YPCCC Webpage](#)), audiences are not passive receivers of CCC but are better considered as diverse audiences who have their own pre-existing beliefs, attitudes, and values, and who actively interpret and construct their own meanings from the messages they receive. Against this background, CCC can increase its effectiveness by better understanding specific audiences and tailoring its messages accordingly. This can be achieved, for example, by appealing to the specific values and beliefs of a given audience (e.g. framing). Another source of variability in considering the Receiver comes with the three qualities of climate change as a phenomenon, which we described in [Section \(2\)](#): Climate Change is abstract, novel, and psychologically distant. These qualities make it difficult for people to reflect and make rational decisions. Accordingly, research has identified key psychological, emotional, and contextual factors involved in CCC at the *receiver* level, these are summarised in the figure below and will be detailed in the next [Section \(5\)](#)

To address these potential barriers, communicators can adopt several strategies in their *message*. We briefly introduced *information* and *persuasion* above and we will provide further recommendations in [Section 6](#).

3. Climate change communication model



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Figure 6: The psychological, emotional, and social barriers at the receiver level in the climate change communication model

Behaviour Change

The fourth and last component of our CCC model, the intended **behaviour change**, introduces yet another level of complexity that is highly important to consider when planning CCC strategies. Essentially, any behaviour that can have a positive pro-environmental effect aimed at mitigating climate change can be listed here. And indeed, our literature search has yielded a large variety of behaviours that have been analysed in the context of CCC and sustainability more broadly. We have categorised these behaviours into five different domains, each of which contains several relevant behaviours (see Figure 7). The five behavioural domains of change we identified in our systematic literature review are (1) Mobility, (2) Consumption, (3) Conservation, (4) Pro-environmental behaviours, and (5) Political action.

3. Climate change communication model

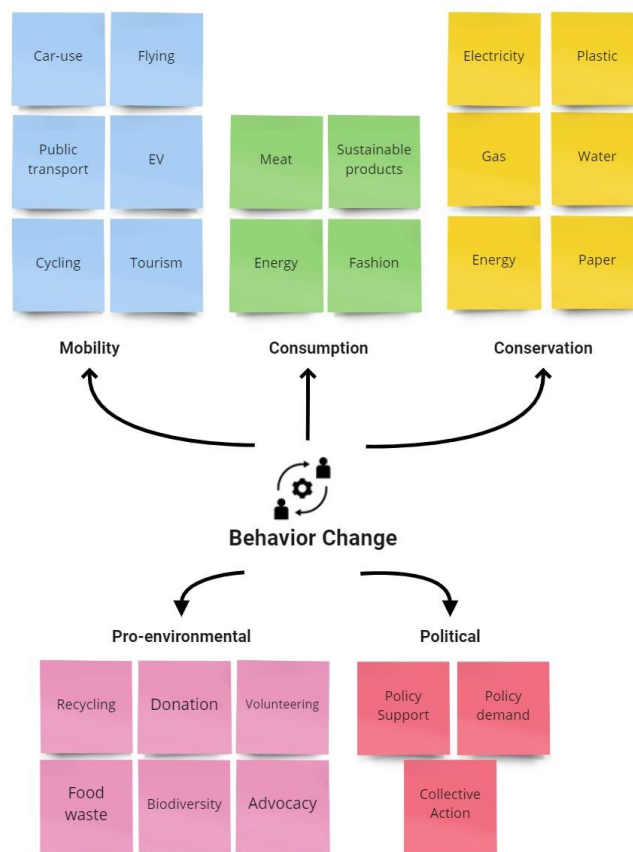


Figure 7: The types of behaviour change domain in the climate communication model.

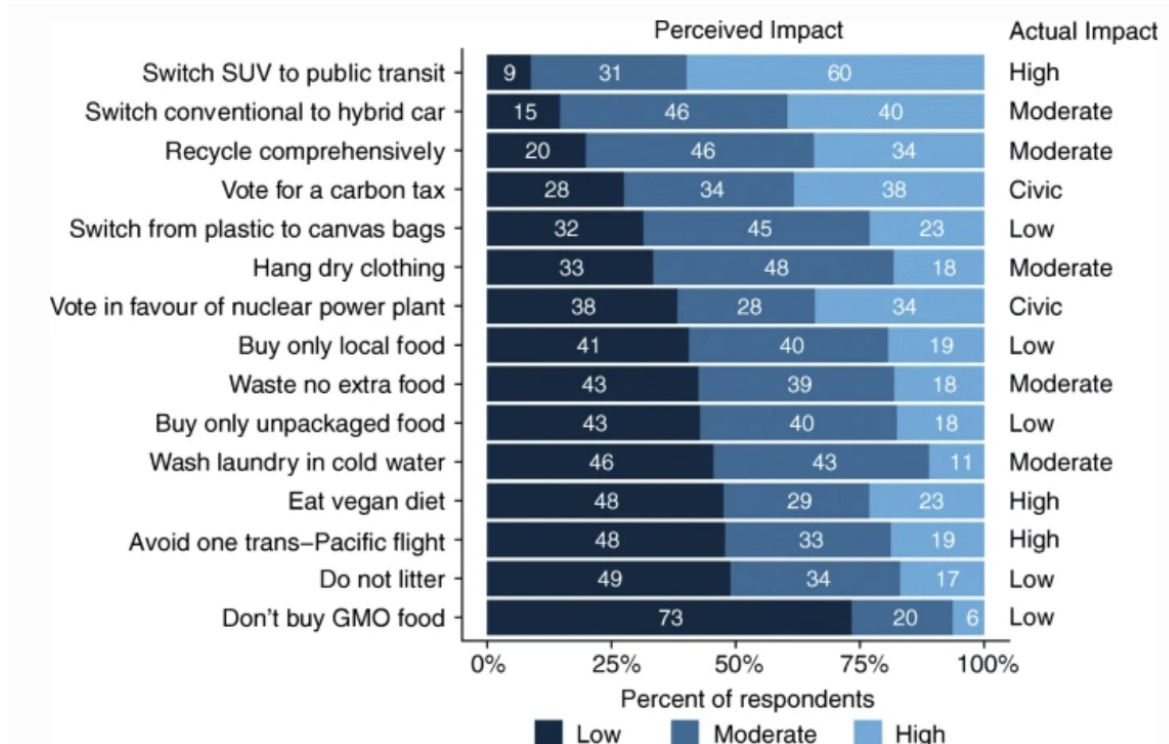
For example, the *Mobility* domain pertains to research that seeks to facilitate behaviour change to either reduce carbon-intensive mobility behaviour such as flying or combustion-engine car driving or to increase the usage of less-carbon intensive vehicles such as public transportation (e.g., train, bus, car-sharing), bicycles, or the switch to Electric Vehicles. The *Consumption* domain refers to research that aims at reducing carbon-intensive consumption behaviours (e.g., meat, fast fashion) and/or increasing less-carbon intensive consumption behaviours (vegetarian and vegan diets, sustainable product purchase). The *Conservation* domain is probably the best-studied behavioural domain in terms of published scientific articles. In this domain, scientific studies have tried to facilitate behaviour change such that individuals reduce their usage of materials (e.g., plastics, paper, metals, water) and energy (e.g., electricity, gas). In addition to *Mobility*, *Consumption*, and *Conservation*, a number of studies look at a variety of so-called pro-environmental behaviours.

3. Climate change communication model

Pro-environmental behaviours can include any behaviour which has a positive, indirect impact on the environment. Example behaviours are making donations to environmental organisations, participating in biodiversity programs, reducing food waste at home or in organisations, or volunteering in a pro-environmental organisation. The last behavioural domain we identified can be classified as the *Political* domain. In this domain, a number of studies focus on climate change mitigation and more generally sustainability behaviour in terms of supporting policies (e.g., supporting a carbon tax, subsidising renewable energy and technology, etc.). Besides policy support, a number of studies also explore the potential of behaviour change in terms of collective action or public protest, in other terms: *active demand for policy*.

Previous research shows that different communication and intervention methods can have different successes depending on which domain and type of behaviour are targeted. Thus, CCC is well advised to consider which type or domain of behaviour is aimed at to maximise the effectiveness of messaging. The challenge for effective CCC is also to promote the ‘right’ actionable perspectives, meaning to [promote high-impact behaviours](#) such as reduced flying, car driving, meat consumption, and increased active policy demand, and not only low-impact behaviours such as recycling. Another key issue in this regard is to clearly reflect and in turn, [communicate the different levels of environmental impacts that various types of behaviours \(flying, eating meat, recycling\)](#) have. Previous studies have shown that people do indeed exhibit greater willingness and intentions to perform pro-environmental behaviours that they believe are more effective in combating climate change [16, 17]. It is important therefore that members of the public can [distinguish between actions that are low or high impact for mitigating climate change](#). The most effective actions for reducing an individual’s greenhouse gas emissions have been ranked [18–21]. However, newer studies show that misunderstandings in the relative efficacy of pro-environmental behaviours prevail and may have important consequences for climate mitigation efforts. Against this background, Wynes and colleagues [22] have shown that large proportions of [people under- or overestimate the relative efficacy of climate change mitigation behaviours](#) as shown in the Figure below (see Figure 8). The reasons for these misperceptions will be partly explained by cognitive biases in Section 5.

3. Climate change communication model



Proportion of participants that ranked each of the 15 actions as low (dark blue), medium (medium blue), or high impact (light blue). Each action is also labeled at the right for the assessed impact based on past research (Wynes and Nicholas 2017). Actions assessed as low impact account for less than 1% of an average North American’s annual carbon footprint, medium impact account for 1–5%, and high impact account for more than 5%. Note that not all percentage values add to 100% due to rounding

Figure 8. Perceived and actual impact of various behaviour changes (retrieved from Wynes et al. 2020 [22])

For example, the first row in the Figure above indicates that a switch from SUV (Sports Utility Vehicle) to public transit, a high impact behaviour change, is perceived as low or moderate impact by 40% of respondents. Even more stark is the misperception in regard to eating a vegan diet, another high impact behaviour change: Only 23% of the study respondents perceive a vegan diet as high impact behaviour, while 29% perceive it as moderate impact behaviour and a staggering 48% consider a vegan diet as low impact behaviour. These examples clearly indicate that CCC needs to focus on reducing the gap in knowledge by raising awareness about the relative efficacy of different pro-environmental behaviours. CCC is also well advised to focus on high-impact behaviours to maximise its effectiveness.

3. Climate change communication model

Further complexity of CCC lies also in the difficulty to predict behaviour change, as the causality between knowledge, awareness, intentions, and behaviours is not linear. Each of the four components of CCC thus represents potential pitfalls as well as potential entry points to increase the effectiveness of CCC. Besides the four components described in our CCC model, there are additional external factors that can appear as barriers/opportunities to behavioural change such as inadequate structures (e.g. no available public transportation) or other behavioural barriers (see further detail under [behavioural barriers \(5\)](#) and [7](#)). As these are not strictly speaking communication specific, they can additionally be addressed by the second toolbox of behavioural interventions (see below).

4. Climate Change Behavioural Interventions

Besides the above-mentioned climate change *communication* components and strategies, there are additional [behavioural intervention](#) (BI) strategies that have been researched. In our CCC model, these BI strategies could replace or complement the *Message* component. Indeed, a Sender (e.g. a public institution) can implement behavioural interventions targeting a receiver (e.g. the individual) to trigger behaviour change. However, these interventions do not necessarily fit our definition of CCC as they are not always transferable into communication campaigns such as public communication via news, social media, etc. Oftentimes, the interventions require a physical context (e.g. environmental alterations) or direct contact with the *receiver* (e.g. incentives). Nevertheless, most of the literature focusing on actual behaviour change, rather than attitude and intention-focused CC strategies, employs one of the following behavioural and socio-psychological interventions. Furthermore, many insights of behavioural interventions can be translated into communication tools, this will be discussed later at hand with practical examples (see for example in [Show the way](#) (6) and in Box 8).

Behavioural interventions typology

Our systematic literature review yielded 9 broad categories of behavioural interventions. Note that there is no uniform classification of behavioural interventions and considerable overlap between different types of categories are thus unavoidable. To maximise the uniqueness of each behavioural intervention we found we present a classification here that is based on several previous meta-analyses [23–25] and covers a broad range of the most widely used and researched interventions. This overview is thus not comprehensive in terms of all the existing categories of behavioural and social-psychological interventions described in the academic literature.

Table 2: Behavioural interventions for behaviour change

Intervention type	Description
Feedback	This intervention strategy consists of providing individuals or groups with information

4. Climate Change Behavioural Interventions (BI)

	<p>regarding behaviour change along with a comparison with a predefined standard, so as to show the difference with the standard and motivate them to fill the gap. A widely used example of the Feedback intervention is energy-consumption feedback.</p>
Incentives	<p>Incentives refer to any kind of benefit (e.g., monetary rewards, refund and unit pricing programs, gifts, prizes, lottery tickets, discount coupons, social rewards, and non-monetary benefits, etc.) that participants retrieve from their participation in a behaviour change program. Incentives can be used to increase pro-environmental behaviours such as recycling, energy usage reduction, cycling, etc.</p>
Commitment	<p>In the interventions using commitment, individuals commit to produce a certain behaviour or reach a certain goal. This technique is believed to work due to the motivation of the individuals to appear consistent, since inconsistency (e.g., a person says s/he will do something and then does not do it) is commonly viewed as a socially undesirable trait. Commitment interventions can also be employed in a variety of behavioural change domains like mobility, conservation, and consumption. Commitment interventions can be set at the private or public level.</p>
Goal-setting	<p>Interventions in this category try to change psychological processes, such as promoting goal-setting, implementation intentions, or engagement, towards behaviour change. Goal-setting interventions can also be employed in a variety of behavioural change domains like mobility, conservation, and consumption.</p>
Social comparison	<p>These interventions tend to provide a comparative reference with respect to the mitigation behaviours of close others, such as neighbours, colleagues/friends, or fellow citizens, based on social influence and social comparison. These interventions also activate the influence of social norms.</p>
Social norms	<p>These interventions use the influence of social</p>

4. Climate Change Behavioural Interventions (BI)

	<p>norms to facilitate behaviour change. Individuals may change their behaviour to conform to social norms either as a means to gain others' approval, or/and to act appropriately.</p>
Social modelling	<p>Social modelling interventions include any kind of passing of information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour). The effectiveness of this type of intervention rests on Bandura's learning theory, which assumes that people learn through observation of the behaviour of others, imitating this behaviour especially when it is relevant, easily understandable, and permits the individual to reach meaningful and positive outcomes.</p>
Choice architecture (<i>Nudging</i>)	<p>Usually designated as nudges, these interventions influence behavior by removing internal and external barriers. Nudges aim at facilitating a decision or adoption of mitigation behaviour by removing motivational barriers or physical barriers by altering the structure of the environment in which people make choices (see environmental alterations). Examples are setting default options such as reducing plate/glass size or setting air conditioning by default to higher temperatures. Choice architecture is best understood as an umbrella term that comprises several of the here described interventions such as social norms and environmental alterations.</p>
Environmental alterations	<p>This type of intervention consists of making pro-environmental behaviours more convenient and easy to perform by modifying the physical environment, for instance by increasing the proximity or number of recycling bins, changing their appearance, or providing home equipment for sorting waste.</p>

We will present existing meta-analyses comparing each of these intervention methods in their relative effectiveness in facilitating behaviour change in the more detailed results of our literature synthesis in Section [7](#).

5. Review of social, psychological, and behavioural factors on CCC and behaviour change

As presented in our CCC model, we focus on change in [climate change mitigation behaviours](#) which essentially include every behaviour that would reduce one's own or collective impact on climate change. Besides [individual behaviour changes in lifestyle](#) (e.g., reducing one's emissions by flying and driving less, eating less meat, conserving energy, etc.) [political behaviours](#) such as *supporting national or subnational climate change mitigation policies* (e.g., voting for supply-side and demand-side policies) as well as *active demand for mitigation policies* (e.g. protesting, signing petitions) are important behaviours affecting climate change mitigation.

Given the continuing rise in global carbon emission [9], it is fair to say that current CC communication does not yet sufficiently facilitate [significant behaviour change](#). More precisely, the necessary changes in behaviours that would be required to significantly improve the current climate change trend are not observable, or insufficient and slow. Unfortunately, not only does previous climate change communication largely fail in invoking the necessary behaviour changes, but, many studies also indicate that CC-communication can trigger [defensive mechanisms or maladaptive reactions](#) to the topic that in turn can constitute obstacles to positive behavioural change. The most simple and perhaps most common observance in the literature is that climate change communication can lead to increased awareness that climate change exists, is human-caused and a reason to be concerned but not actually translate into behavioural changes, thus resulting in [inaction rather than action](#). In some cases, CCC awareness or concern translates into behavioural change but in an [inconsistent](#) and [insufficient](#) way. For instance, it has been observed that people adopt only easy and single behaviours (e.g recycling). This uptake of [low-impact behaviours](#) and the so-called [single action bias](#) are first limitations to the necessary systemic changes towards low-carbon lifestyles. In more problematic cases, the new “green behaviour” is

observed to legitimise or encourage other less-desirable ones (e.g. switching light bulbs to LED makes people less attentive to switching lights off). This so-called *rebound or moral licensing effect* also impedes the desired mitigation effect of changing behaviours. In more concerning cases, climate change communication can also invoke *defensive mechanisms* such as *disbelief*, *scepticism*, or outright *denial* which might lead to *avoidance* or *reactance* (showing the opposite behaviour to that advocated). CCC can also lead to *maladaptive reactions* such as emotional reactions including *hopelessness* or *anxiety* lacking positive behavioural change dynamics [13].

In line with our CCC model, the individual or the *receiver* is one of the key constituents of effective CCC. Thus social and environmental psychologists, alongside behavioural scientists have explored the various factors and processes that are involved when a given receiver processes information on climate change. Researchers have identified several cognitive, social, and emotional processes leading to both positive and negative reactions which impede positive behavioural change. These are summarised in the Figure below (Figure 9).

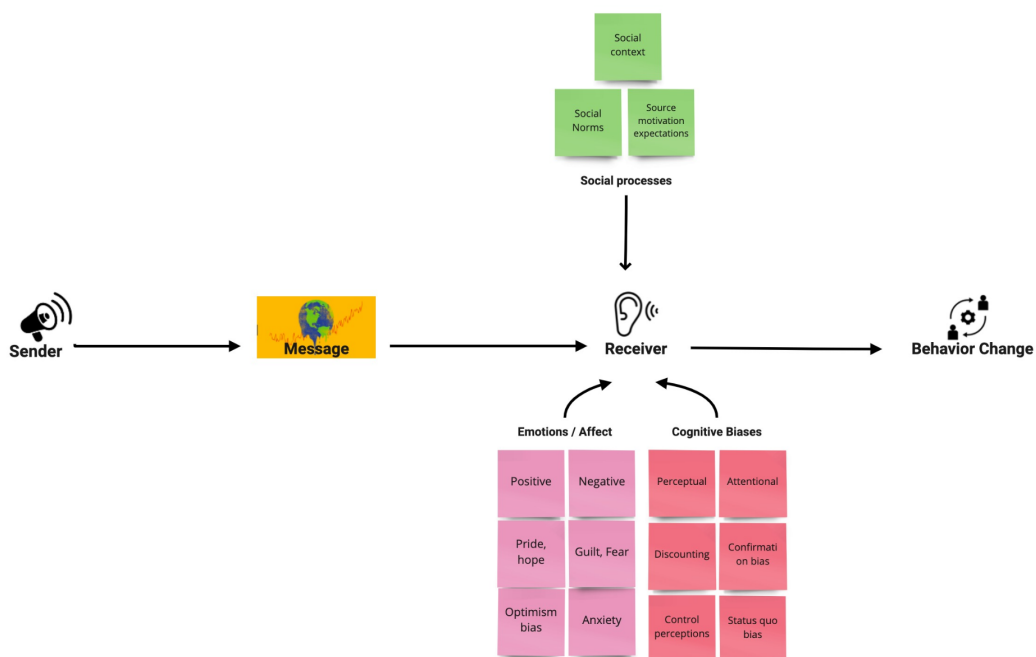


Figure 9: Cognitive, social, and emotional processes influencing how climate change communication translates into climate change mitigation behaviours (adapted from De Vries 2019).

First of all, it is important to remember that the receiver, the individual, is constrained by cognitive processes that are not easy to predict, due to dual-processing as well as pre-existing mental models. These aspects will be explained quickly because they help to understand why individuals face cognitive, emotional, and social processes when dealing with complex information or situations such as CC. Individuals possess **two distinct information processing systems** that are both influencing how they take up information and make decisions. The first system is fast, automatic and intuitive, affective/emotional (*the experiential system or system 1*) and the other is slow, deliberative and rational, and effortful (*the analytical processing system or system 2*) [10, 11, 13]. In theory, the second system should allow individuals to process information about climate change accurately and reliably and create adequate attitudinal and behavioural change. However, the complexity of the topic can perturbate the analytical process leading people to misprocess information. Indeed, people can (consciously or unconsciously) avoid the information or switch to the intuitive thinking (experiential processing system) and thus misjudge the severity of climate change according to their intuition which is highly influenced by emotions. Additionally, people have different **mental models**, meaning “different understandings of the surrounding world” [10]. Mental models depend on existing knowledge, experiences, and opinions, and these will influence both processing systems. So these are also factors explaining why people react differently to CCC and why they show different cognitive shortcuts, and emotional and social responses.

Cognitive biases

In this context, people tend to have **cognitive biases** defined as distorted mental representations of climate change [26]. Indeed, it is observed that people show mental shortcuts to understanding and dealing with climate change and thereby deviate from rational judgements and decisions [13]. These biased judgements and decisions will be described below, focussing on the biases that are specifically present in the context of climate change. It will also be mentioned how emotional and social processes reinforce these biases.

Climate change biases can be distinguished between [perceptual biases](#), describing how information about CC can be misperceived, and [attentional biases](#), explaining how attention to CC information itself can be biased [27].

Table 3: Cognitive biases faced by individuals in the CCC context (adapted from Luo & Zhao 2021)

Type of bias	Description	Examples
Perceptual	<i>People have different and sometimes incorrect climate change-related perceptions</i>	People perceive a given outcome as less important when it occurs in the future compared to the present (discounting) Perception of greenhouse gas emissions associated with individual actions or objects is often incorrect (misperceptions) People perceive lower control and efficacy compared to their potential contribution (low control and inefficacy perceptions) People tend to underestimate the scope or severity of a problem (optimism bias)
Attentional	<i>People attend differently to CC information</i>	People seek and remind information differently according to their predispositions and motivations (e.g. confirmation and recall bias) People concerned with climate change attend more readily to climate-related words or images Attended environmental risks are judged to be more severe than unattended risks

[Perceptual biases](#) [27] describe the fact that people perceive the risk or threat of CC differently and sometimes falsely. There are three main explanations for this. Firstly, individuals have different [mental models](#) [10] which will influence the way they perceive and react to a problem [10, 26]. An individual who understands the climate change processes or who has experienced a climatic event can perceive higher CC-related risks than someone who has a poor understanding and no personal experience with CC. Social psychology explains that “[selective perception](#)” can occur, meaning that individuals are influenced by in-group and out-group norms of climate change beliefs (or disbeliefs) and that they take up

perceptions according to their own social group (e.g., a political party). Additionally, perceptual biases arise from *misperceptions* of climate-related information, such as underestimation of certain impacts. This is due to misevaluations or miscalculations, where scales and effects are incorrectly perceived. Perceptual biases can again be explained by the fact that climate change is abstract, novel, and distant. A few examples of CC-specific perceptual biases will be described subsequently.

A strongly observed perceptual bias in the CC context is *discounting*, the fact that humans tend to discount future, distant, and uncertain events both in terms of positive and negative outcomes [11, 13]. This bias partly explains people's inaction because it reduces their sense of urgency and severity in relation to the actual risk. Additionally, it makes current issues appear as the most important, leading people to favour (avoid) current benefits (risks) instead of anticipating future problems (*present bias*). Discounting is a general cognitive process, but it is reinforced in the CC context due to the psychological distance that people have from climate change. This distance is both spatial and temporal as CC has mostly been described as an event that has consequences in the future and (most severely) in southern countries [13]. Discounting can also be explained by social distance, as long as climate change is not expected to impact people of one's own social context (for Europeans, CC affects polar bears and people in the global south). Secondly, in the CC context, risk misperception of CC may simply arise from incorrect assumptions or calculations leading people to misevaluate or perceive the impacts of specific actions. For example, people often *incorrectly perceive GHG emissions* related to specific actions or objects [26]. Lastly, other perceptual biases that are recurrent in the CC context are *control perceptions* [13, 26], where "people wrongly infer that they have low (or high) control" over climate change or related processes such as mitigation policies [13]. One example is the misperceptions of self-efficacy, such as the fact that people believe that their own actions have no, or little effect on climate change mitigation. As mentioned earlier and highlighted in Figure 8, large proportions of people under- or overestimate the relative efficacy of pro-environmental behaviours [22] which can be a barrier to orienting people toward high-impact behaviours. These misperceptions are again related to the fact that CC is *novel* and *abstract*, leading to the fact that it is hardly processed and remains very abstract in people's minds.

In addition to perceptual biases, people tend to show *attentional biases* [27] that explain why people show more or less attention to climate change. Here again, mental models and individual motivations (including political orientations and ideology) influence the way people attend to CC information (*selective attention*). People might thus only recognise, process, and remember information that is familiar to or matches one's mental model. This can be a barrier to climate change communication as information on climate change might not even reach people's attention, and thus impede the information processing needed to understand and feel engaged with climate change. Even more problematic is *motivated cognition* which describes the fact that prior motivation, such as personal goals, can influence the way people *seek* and *use* information.

Two specific examples have been identified by researchers as key barriers to raising concern and motivation about CC. A so-called *confirmation bias* shows that people actively seek information that confirms their own mental model [10, 26]. This makes it a challenge for communicators to reach the part of the audience that is not yet convinced. Indeed, if a message is too much in contradiction with one's beliefs, chances are that this person either avoids, denies, or quickly forgets the message. Secondly, a reinforcing process is the *recall bias* mechanism where people recall false memories that support their beliefs. So even when individuals face new information, they might (un-)consciously deny it due to falsely remembered information [26]. These *attentional biases* are problematic as they reinforce incorrect perceptions (*perceptual biases*) and thus perpetuate conflicting beliefs and with that the critical polarisation of climate change. *Cognitive rigidity* adds up with these biases and explains the inability of people to adapt to a new context and to take up new beliefs [26]. As mentioned in the introduction, the *novelty* of the topic in the public debate remains a key barrier to CCC.

The above-mentioned biases are strong barriers to climate change communication and positive behavioural change because they provoke *biased decisions* that are not adequately adjusted to the urgency of the climate change crisis. For example, *discounting* is the source of the *present bias* where people tend to prioritise objectives or tasks that are temporally and spatially closer over the ones that are more distant, even though these have fewer benefits (or higher costs) than in the future [11]. Added up with *cognitive rigidity*, people are averse to

changes and do not adopt new options or behaviours: the *status quo bias* [26]. Furthermore, perceptual biases have been shown to lead people to misperceive the impact of their own actions, thus leading to inadequate or insufficient action. For example, the single-action bias describes the fact that people perceive a reduced climate risk after taking a single action thus discouraging additional actions. Problematic is also that social processes and emotions (described below) reinforce these biases. We have described how socially built mental models influence attention and information uptake and thus *perpetuate misperceptions* and disbeliefs. Emotions can also trigger biased decisions or maladaptive reactions. For example, people might underestimate the scope or severity of a problem to seek positive affect, described as the *optimism bias* [11, 13]. This emotional reaction is also described as denial-based hope [13] where people deny CC based on over-optimism. Finally, defensive mechanisms such as *denial or avoidance* can also occur when the biases create negative emotions. For example, low efficacy and control perceptions make people feel *hopeless and overwhelmed or angry* and thus reject these feelings by avoiding the issue [13].

Further social processes and emotions that influence the impact of CCC on behavioural change will be described below and can be read in relation to the cognitive barriers. Indeed, social processes and emotions can reinforce certain cognitive biases, and vice-versa.

Social processes

Besides cognitive biases and emotional processes, the examined literature also points to the fact that further social processes influence CC-related decision-making and behaviours [11, 13].

First of all, we have discussed above how people's predispositions influence how they seek and process information. Above and beyond individual predispositions (*mental model*), one's social context such as the specific socio-cultural background, political affiliation, and geographical location will influence the values, beliefs, perceptions, and subsequent behaviours. The mentioned *novelty* of the topic in the public debate can explain why CCC is difficult as it has not yet an established place in everyone's social context.

More specifically, the social context influences a person's perception of the [social norm](#), meaning “the mental representation of the appropriate behaviour” and people tend to behave according to that social norm (imitate or “follow the norm”). *Social norms* can be constructed upon the perception of the behaviour of the majority ([descriptive norm](#)) or the perception of the behaviour that is approved or disapproved by the majority of the social group ([prescriptive norm](#)) [11, 13]. Social norms thus emerge from - and are perpetuated - by social groups such as one's family, neighbourhood or political party, or other social references that people identify with such as national values or personalities. People's behaviours are strongly motivated by these norms. People tend to behave as they think others would do - or would approve. They will evaluate their own behaviour accordingly - thus feeling pride or validation if it aligns with social norms, or guilt and disapproval if not. [Social comparison](#) can also lead people to change their behaviour when they see their peers behaving differently. As such, social norms need to align with the required sustainable behaviour in order to be promoted and adopted largely [11, 13]. Here again, the fact that CC is a novel topic can explain why sustainable behaviours are not yet a universal norm. It seems that it is not yet clear to people which are the actionable solutions and behaviours, and when these are known they might still be conflicting with past norms (e.g. carbon-intensive lifestyles, such as driving an SUV, are still important to people's perceived social status but it is in conflict with the required change towards public transportation, cycling or car-sharing).

Individuals also have [social expectations](#), meaning expectations about behaviours and intentions of others, and that they respond accordingly [11, 13]. These expectations can be towards other individuals according to social norms. For example, people tend to behave according to how they expect others to behave. In the context of CC, individuals might expect others to not behave sustainably, this might provoke inaction or reactance (referring to the tragedy of the commons). Secondly, the CCC model highlights that the sender plays a crucial role. Indeed people have expectations about the intention of the communication source. This is specifically the case for public actors such as governments, public institutions, NGO's, and large companies. The [source expectation](#) is built upon the perceived and actual social role of the sender (e.g. people expect public institutions to act for the common interest). Expectations are also influenced by the trust that people have in the

messenger and this trust derives from past performed behaviours (e.g. distrust in politicians that acted in others' interests such as the fossil fuel industry). Some studies have shown that distrust in the messenger can create non-compliance or reactance to CC-related policies and prescriptive norms. Distrust appears when the messenger violated social expectations and when people perceive manipulation (e.g. greenwashing), unfairness/injustice, or dishonesty, and all that can create reactance to the CC message [13].

Emotions

Some studies identified emotions as important drivers of CC-related risk perception and behaviours [28] and as being intertwined with cognitive processes [13]. **Emotions** can result from an appraisal of an event or object (e.g., climate change), but can in turn also influence one's motivational tendencies (e.g. defensive reactions), evaluations, and judgments (risk perceptions) towards a given event [28]. The complexity of climate change (abstract, novel, and distant) makes it however difficult to predict the role and place of emotional processes in CCC. On the one hand, the novelty and importance of the topic are expected to trigger strong emotions. On the other hand, it remains an abstract and distant issue to which people might not feel emotionally connected with.

Additionally, although emotions are considered strong behavioural motivators, their effect on positive behavioural change remains unclear. As emotions activate the intuitive and fast processing system, emotional responses can prevent more rational and deliberative thinking and thus foster mental shortcuts, cognitive biases, and subsequent maladaptive actions [13]. In certain contexts, **negative emotions** such as *fear* or *guilt* have led to denial, defensive avoidance, and reactance to CC [13]. These reactions can be explained as protective mechanisms with the goal of quickly removing the negative feelings associated with these emotions. Moreover, researchers have identified it as a control action, where people react in a way to maintain self-determination, either to control their affective state or to maintain their perceived control when they identify manipulation attempts from the communicator (*source expectation*). CC communication loaded with pessimistic acknowledgments has also been observed to provoke negative emotions such as hopelessness leading to a "paralysing effect" or anxiety. This can arise from a feeling of being overwhelmed by the issue and not

knowing where to start changing or a feeling of disempowerment related to the previously mentioned perceptions of control and efficacy. That being said, *positive emotions* such as *hope* and *pride* also show contrasting effects. They might trigger positive behavioural change in certain cases (constructive hope) but in other cases, they seem to create forms of denial (denial-based hope) and thereby encourage inaction or negative behaviours [13].

On the other hand, emotions play a “positive” role in detecting information, appraising an issue, and orienting attention and information processing [29]. Indeed, emotions are recognised to act as a filter, prioritising attention, concern, and action of individuals on information or events that are relevant to them, because they are appraised as either being a risk to one’s well-being or values (negative emotions) or as supportive (eliciting positive emotions). So they can support effective information uptake and subsequent behavioural change. Inversely, cognition also influences emotions. As such, providing “clearly understandable and value-relevant” information about climate change can activate the appraisal of a threat and thus elicit the experience of emotions[29].

The direct role of emotions in triggering behavioural change is also discussed in the literature. Emotions and related expected pleasant or unpleasant feelings (affect), are considered as important drivers of sustainable behaviours, as people are likely to act in a way that favours positive experiences over negative ones [29]. For example, people can experience a so-called *warm glow*, a positive emotional reaction in anticipation of or after accomplishing a pro-environmental behaviour which in turn can increase motivation for future pro-environmental behaviours [28]. However adaptive defensive mechanisms due to negative emotions (such as fear) can lead people to avoid the topic and thus not act upon it. This can again be explained by biases such as the present bias or discounting, where people tend to favour current experience (not thinking about climate change) even if future experiences might be worse. Negative emotions can also only trigger the *single-action bias*, where individuals perform one action with the goal to reduce their negative feelings related to a sense of guilt or fear, but without acting effectively against climate change. In contrast, the above-mentioned feeling of warm glow describes that people can experience positive sensations by behaving pro-environmentally (sense of *pride*, satisfaction) and this positive

sensation, in turn, can be a powerful motivator for further pro-environmental behaviour change.

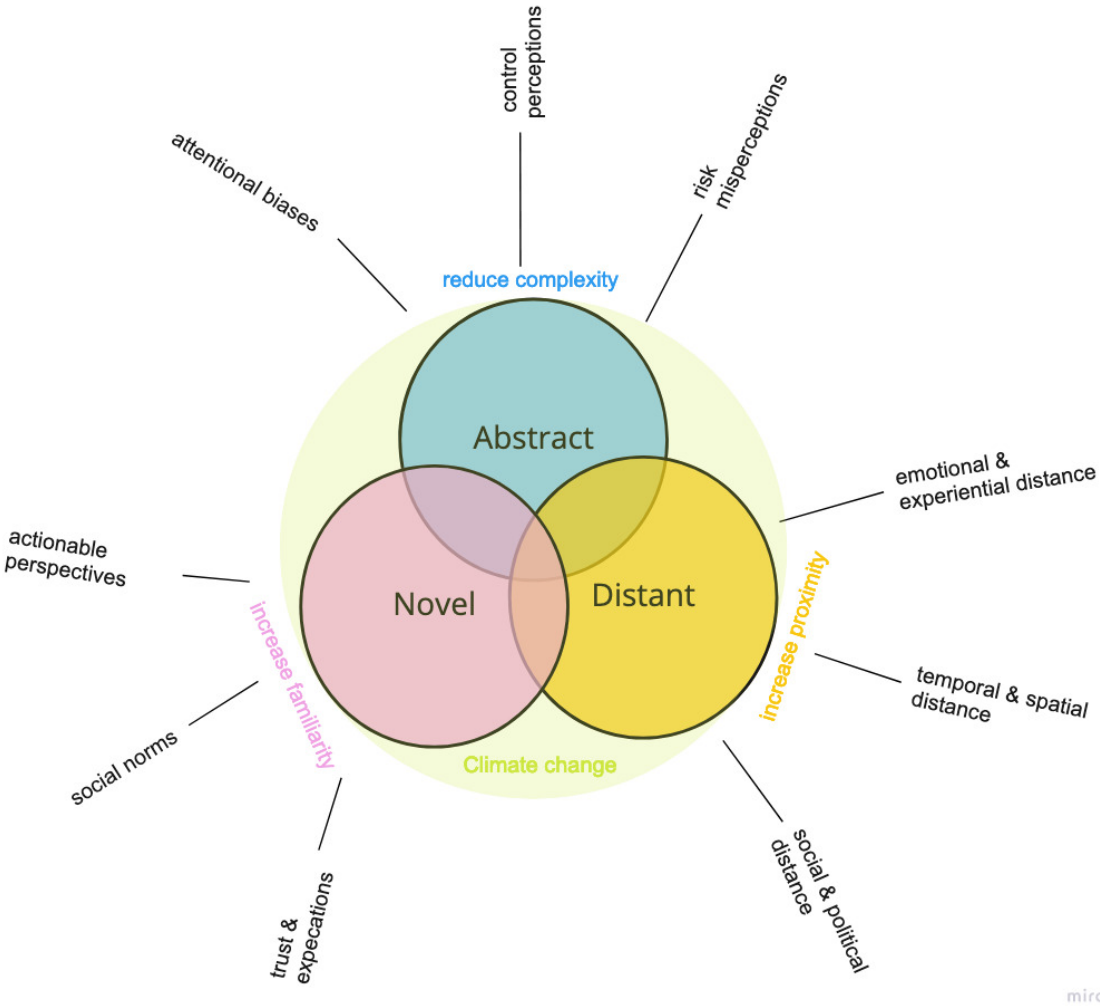


Figure 10: Social and psychological factors on CCC and behaviour change and their links with the complexity of climate change

In Figure 10, we visually summarise the cognitive, emotional, and social normative barriers and how they relate to the three qualities of climate change as an abstract, novel, and psychologically distant phenomenon.

Behavioural factors

Behavioural science provides an additional perspective to the lack of pro-environmental change, as it shows how **behavioural factors** add up with the communication barriers.

First of all, at the Receiver level, the cognitive, emotional, and social barriers to communication are not always sufficient to explain that CCC does not trigger the required behavioural changes. Indeed, **external factors** can influence to which extent people can take up the intended behaviour come into play. The example of communication encouraging sustainable mobility (car-sharing, cycling, and public transportation) speaks for itself. Even with encouraging communication, people might face structural barriers such as the fact that the immediate surrounding is not equipped with cycling roads or public transportation. As such, the **physical context** in which people make decisions is an important lever for effective behavioural change [24]. This acknowledgment is key in the so-called “nudging” theory (or choice architecture) formalised by Thaler and Sunstein in 2008 [30] and taken up in the field of environmental psychology. Additional **individual motivational factors** can come into play. These can be economic (e.g. not being able to afford public transportation such as long-distance travelling by train) or time-related (e.g. the time available to bring kids to school). These motivational factors can also require *behavioural interventions* that would facilitate behaviours by removing these barriers (e.g. economic incentives).

Moreover, Nudging Theory also recognises the role of the **psychological and social context** to pro-environmental decision-making and explores how these represent behavioural barriers. Indeed, the previously mentioned biases and reactions related to dual-processing are also influencing the effectiveness of behavioural interventions, outside the communication field. As such, **contextual factors** can lead to biased and emotion-driven decisions and behaviours. A recent meta-analysis mentions factors such as the “limited access to decision-relevant information”, “the limited capacity to evaluate and compare choice options”, as well as “the limited attention and self-control” [24]. In general, the **behavioural barriers** can be described as **physical and psychological efforts** that can discourage behaviour change or accurate information uptake.

5. Review of social and psychological factors on CCC and behaviour change

A large field of behavioural science has taken up this topic to identify behavioural interventions that could encourage CC-mitigation behaviours. These include [providing better decision information](#), [improving decision structure and environment](#) as well as [assisting decisions](#).

This research will be reviewed in a subsequent section (Section [7](#)) and can be considered a complementary tool for communicators. Inversely, those implementing behavioural interventions, can highly increase the efficiency of these interventions if coupled with efficient CC-communication strategies.

6. Review of CCC guidelines: General rules

Several scholarly guidelines have been developed in an attempt to help communicators overcome the above-mentioned social, psychological, emotional, and behavioural barriers to induce positive climate change mitigation behaviour. We consulted and reviewed the most prominent guidelines that are recognised by the academic community including scientific articles and grey literature from trustworthy organisations. Below, we summarise our review under 5 general principles that can be adopted by communicators.

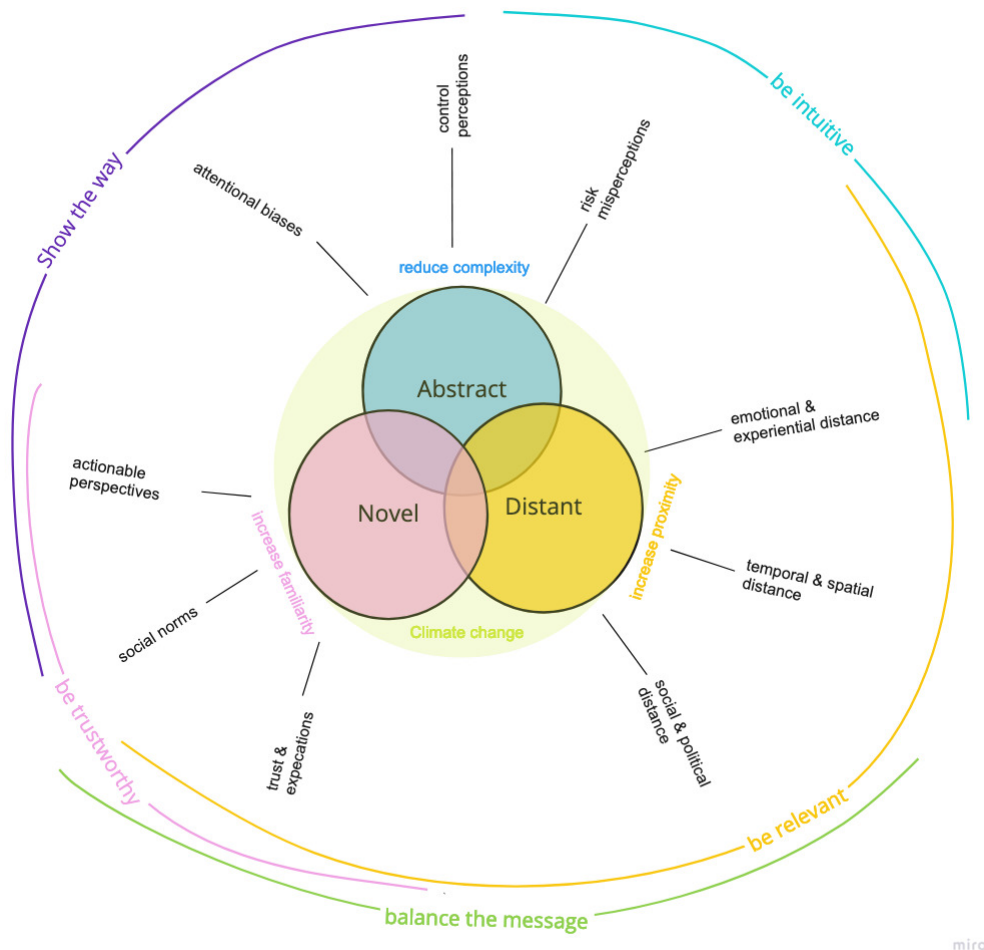


Figure 11: Five general principles for CCC to overcome the complexity of climate change (abstractness, novelty, and distance) and the consequent psychological and social barriers.

These 5 principles are hoped to trigger positive behavioural change by circumventing some of the defensive mechanisms and barriers that we outlined in the previous sections. Figure 11 above highlights how the 5 principles can provide an overarching toolbox to address the complexity of CCC.

Figure 12 (below) more specifically depicts how each of the five principles addresses the individual psychological and social barriers involved in CCC. All these principles will be described in more detail and with concrete examples in the following sub-sections.

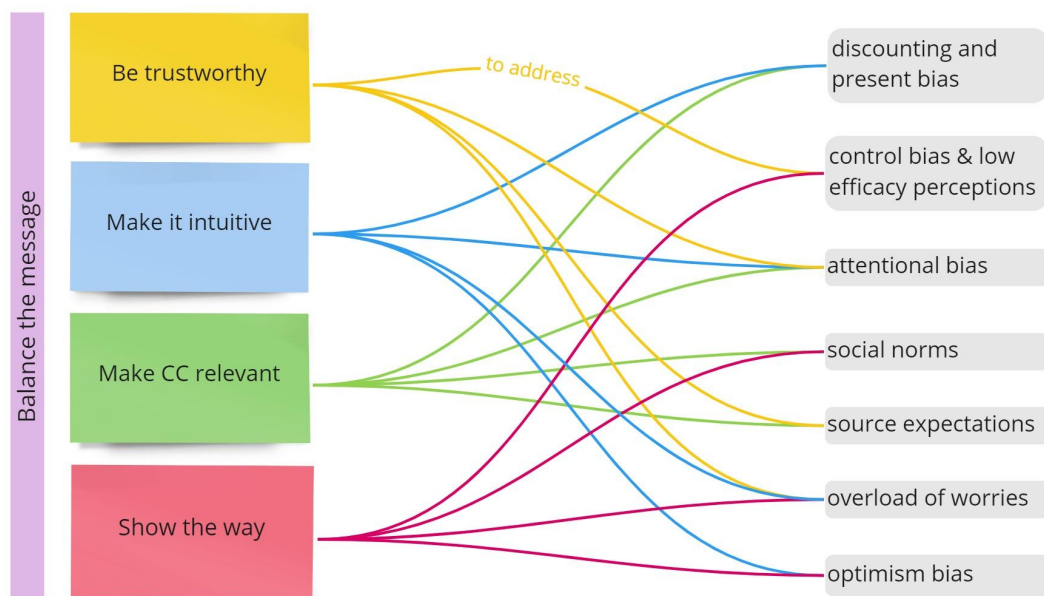


Figure 12: General principles to address CC-specific social and psychological barriers

Climate Change Communication should:

Balance the message

As highlighted in the graph, CCC has to find the right balance to address the complexity, novelty, and distance of climate change. Communicators can assist people to better understand CC without hiding its systemic nature, increase people's familiarity CC and reduce psychological distance to it without creating defensive mechanisms. The

overall goal of CC-communication should be to underline the seriousness of the topic without undermining the potential for positive behavioural change. All the examined CCC guidelines recommend to [balance messages](#) in terms of arguments, strategies, and framings to help trigger more balanced and constructive reactions (and thus counter single defensive reactions) as well as to reach different audiences. [Balancing the message](#) can thus be considered as an umbrella rule - and can be applied to almost all subsequent rules (be relevant, be trustworthy, make it intuitive, show the way). We will get back to the breakdown of this principle in the following paragraphs but here is an overview of further detailed examples: Communicators can balance a message between different approaches when talking about climate change such as providing arguments that highlight several aspects of CC such as framing them in economic or health arguments. Communicators can also aim for intuitive formats that balance information between images and written information, scientific, and more storytelling narratives. Finally, messages can support both the individual and collective aspects of climate-related actions.

To sum up, the guidelines we consulted recommend finding the right balance between different perspectives to climate change and formats of communication. It can be applied to the different components of the CCC model, thus considering different senders, and types of messages, addressing different receivers, and promoting different behaviours. The intuitive thinking behind that is that the audiences can react very differently to communication because of their social and cognitive specificities, and thus using balanced and diversified strategies maximises the chances to reach the whole audience and trigger more moderate reactions.

More specifically, communicators are urged to find a better [balance between the positive and negative approaches to CC](#). First, they draw attention to the emotional load of CC messages, in order to avoid the pitfalls of backlashes that these can have in terms of behavioural change. Moreover, they recommend moving away from [overly negative messages](#) purely based on fear. It has been the main approach up to now as the goal was to make the urgency visible (examples of videos showing a long list of

dramatic consequences of climate change). As it has been creating defensive mechanisms (avoidance, denial..) they recommend completing these messages with [hope-based messages](#) in order to avoid - or overcome- defensive reactions and to trigger constructive reactions (constructive hope). Similarly, it is recommended to [avoid hope-only messages](#) as these are considered as not credible and risking to trigger an optimism bias leading to inaction. In the same vein, communicators should promote [balanced pictures in terms of gains and losses](#) of action - and inaction. Acknowledging both the advantages and disadvantages is expected to support the credibility of the message and to increase acceptance of potential changes [13, 14]. Furthermore, it has been shown that people react differently to potential losses or gains. Some people have a promotion focus, where their actions are triggered by potential gains, while prevention focussed people tend to behave in order to avoid losses. Communicators can thus try to tailor their messages with information and wording that presents both gains and losses (see examples of words that appeal to both orientations, p.8 in [10]). In the words of Van der Linden [11] “Nobody likes losing (but everyone likes winning)” thus presenting benefits of climate action instead of only the losses of inaction can encourage behaviour change or policy support. [All in all, communicators should try to integrate positive elements in their discourse, without diminishing the severity of the topic, nor the urgency of action.](#)

In general, cc communication should carefully avoid creating uncertainty and ambiguity in their messages. This principle of [balancing the message](#) does not mean moderating pro-environmental discourse but rather using different strategies to maximise chances to reach the largest audience possible, and with that encourage pro-environmental beliefs and behaviours.

Box 2. ActNow as an example of CCC campaign

The United Nations launched a campaign for individual action in 2018 during the 24th Climate Change Conference (COP 24), combining a website ([ActNow](#)), a mobile application ([AWorld](#)) as well as several social media campaigns and challenges (such as [#MyClimateAction](#)). The following boxes and text will contain concrete examples from this campaign in order to support and illustrate the five practical principles we propose in this section. The examples are retrieved from the website and the application and these sources will be listed at the end of this report.



Be trustworthy

Communicators can win the [trust](#) of the audience by being honest, realistic, and empathic. This is meant to be achieved by providing credible information, different perspectives on the climate change picture, and dealing with uncertainty, and showing empathy.

As highlighted earlier, some *defensive mechanisms* to climate change communication have been identified as emerging from misunderstanding and misperceptions, mistrust in the messenger's motivations, credibility and fairness (c.f social expectations), conflicting social norms, and polarisation. These can also partially be explained by the *novelty* and *abstractness* of climate change. By [leveraging trust](#), climate change communication can hope to increase acceptance of climate change policies and mitigation behaviours and thus circumvent potential pitfalls.

First, it is straightforward that providing [evidence-based information](#) is the initial step toward correcting misperceptions of climate change and creating consensus. Credible

information can gain the trust of individuals that are characterised by disbelief and denial of climate change and be a tool to counter the above-mentioned confirmation bias. Indeed once the communicator has the audience's trust, he/she might be able to anticipate avoidance and thus change people's mental model by correcting misconceptions, or misinformation [10]. In general, science-based information plays a crucial role in climate change communication as it provides a neutral (non-political) and thus trusted source of information that is difficult to contradict. The Intergovernmental Panel for Climate Change (IPCC) is an important source to be used by communicators. Credibility and trust can also be gained when the messenger uses [different arguments and perspectives](#). Talking with one's language and acknowledging one's opinion can be a bridge toward more nuanced and accepted arguments. It can be achieved by pointing at different aspects, causes, and consequences of climate change thus balancing out the predominant "environmental" and "climatic" perspectives to talk about climate change. Communicators can choose to address climate change as a social, political, scientific, philosophical, and agricultural issue. A latter [section](#) describes how choosing a relevant *issue frame* for the topic can also help to "access" people's mental models. Using [trusted personalities as senders](#) is also a way to overcome the confirmation bias by playing with the social norms of a given group and more specifically the source expectations. As people tend to seek and integrate information that confirms their beliefs or opinions, they tend to trust information provided by people sharing similar beliefs and opinions. As such, the example of a pope's message increasing climate change concerns within the religious community is very illustrative.

Scepticism about and denial of climate change is also due to the *abstractness* of the topic, generating a false sense of uncertainty. Communicators can aim at correcting this sense of uncertainty by insisting on the information that is certain and providing [clear information](#) and conclusions that are supported by scientific and political consensus. The IPCC reports provide this scientific consensus and can be used accordingly [10]. The AWorld mobile application for ActNow for instance always provides a transparent explanation of how they computed their numbers and where they found the information. It prevails that certain elements of CC are uncertain and difficult to predict, but the fact

that climate is changing, is human-caused, and will affect us if we don't act, is certain. Communication should focus on this, and be more cautious in scientific communication when using confidence and likelihood terminology which can be misinterpreted [10]. The CRED shows how terms such as "very likely" in the IPCC documents report very high scientific certainty (90 percent or greater likelihood) but are not perceived as such by readers. [Precision and explanation](#) of the causes of uncertainty can also reduce people's scepticism [10]. Finally, the justification of uncertainty can be counterargued and denounced by communicators by simply calling for the "[precautionary principle](#)" [10]. It states that action should be taken when risk of harm is present, even if it is not certain. This principle is internationally recognized (including in the 1992 United Nations Framework Convention on Climate change") and can intuitively be communicated to the public in different messages. This can address *social norms* barriers as it triggers deep values and shows that it is a universal human norm [10, 14]. Furthermore, it can help to reach people that have a prevention focus, meaning that they "prefer to act vigilantly to minimise or decrease losses". [10]

Box 3: Examples of socially supportive communication

"Climate action is a task for all of us."

"Bold, fast, and wide-ranging action needs to be taken by governments and businesses. But the transition to a low-carbon world also requires the participation of citizens"

"Every one of us can make a difference. Our choices matter. Our actions count."

"We can be part of the solution and influence change"

Finally, [showing empathy](#), that is [acknowledging](#) certain beliefs or feelings and showing social support, can also help communicators to overcome defensive mechanisms such as denial of personal responsibility or blaming others and to support greater acceptance of messages [14]. Communicators can acknowledge the difficulty of coping with the climate change topic. This includes acknowledging people's emotional reactions, the disadvantages of efforts related to mitigation actions as well as the limitations of

individual action. If people feel understood and supported, they might feel encouraged to face the announced changes. [Validating emotional reactions](#) and showing social support have been shown to reduce the negative affect that people experience and thus remove these emotional barriers to behavioural change [14]. For example, this goes through communicating the fact that people are not alone in feeling emotions of disempowerment or eco-anxiety and by sharing experiences of others that have overcome these feelings (e.g. retrieved from the CAGCC's guidelines [14]: "*We know this is scary and overwhelming, but many of us feel this way and we are doing something about it*"). Similarly, acknowledging that taking climate change policies and adaptive behaviours has [disadvantages](#) and are effortful can make the messengers and message appear sincere and increase the perceived necessity and legitimacy of these actions [13, 14]. Here is one example: "The bus might not get you there as fast, but it is good for the environment." [13]. Empathy is also proposed as a tool for greater acceptance of more difficult responses (for example, giving up flying and the related freedom of movement) [14]. Here again, [social support and demonstration](#) can be used to encourage taking such actions [1]: "we know it is hard to give up flying but it's possible and necessary, already 999 persons committed to terrestrial travel and feel happy about it". It is indeed expected to increase trust in the messenger which is especially relevant for public institutions [13]. Similarly, acknowledging the limitations of individual actions is an option for communicators to avoid reactance related to a feeling of unfairness and is an opportunity to support group action [13]. In general, highlighting the collective dimension of climate action is crucial to gaining trust and it is expected to increase the *relevance of the message* and *encourage action* (find examples of how to communicate it in [box 3](#)). [All in all, greater trust in communicators and their message is key to behavioural change as it is an entrance to greater familiarity with actionable perspectives and new social norms.](#)

Be intuitive

People need to [understand and feel](#) the message. To do so CC communication needs to be simple, lively, and salient. In line with cognitive insights, the guidelines recommend "Speaking to the two parts of the brain" [10] to maximise the chances of the impact of a message [11, 14]. This means targeting the analytical processing system

(system 2) to ensure that information is correctly perceived and remains longer in people's minds and mental models [10], as well as triggering the experiential processing system (system 1) to capture the audience's attention and emotions. The goal is thereby to both reduce the complexity of climate change and increase proximity to CC (see Figure 11).

Communicators are encouraged to simplify the messages as much as possible. The simpler the message the better it is expected to anchor in people's minds and thus create more "persistent opinions and stable behaviours" [13]. The goal is to break down the complexity of climate change, focus on key elements, use understandable language, and facilitate perception and behaviour change.

Simple messages start with limiting the **amount of information** provided per communication. Communicators could try to focus on some key aspects and clear-cut conclusions. Targeting messages to certain audiences can be a way to focus on the most important aspects of an issue (c.f. framing under "be relevant") [13]. Besides the amount of information, communicators should be aware of how they communicate the information to make it easy to understand and interpret. The goal of a message is here to be **meaningful** to the audience. For that, the language used is key. Communicators are thus recommended to avoid scientific or imprecise language [10, 13]. The CRED provides examples of "better understood words" such as using *human-induced* instead of *anthropogenic* [10]. Scientific terms can be necessary and effective, and when communicators choose to use them they need to be carefully defined. Furthermore, communicators should use numerical information that is easily **interpretable** to avoid any misperceptions. The messages should only contain numbers and units that people can rely to. This can be reached by using units that people are familiar with (default units, [31]) and by using intuitive comparisons. The CRED guideline provides an example of communication encouraging the recycling of newspapers where it uses the size of a well-known building (the empire state building) to show how much 400 000 tons of paper actually represents in terms of volume [10].

As mentioned earlier, a first barrier to CCC is the complexity of the issue itself. As such, the CC topic is associated with an overload of complex information. This is thought to dampen people's willingness and capacity to seek, process, and remember the information [13]. An *attentional bias* can arise from that as people attend to information that they can understand. Additionally, people can start avoiding the topic due to the negative feelings that can arise when people do not understand or feel overwhelmed. Simplifying messages can try to reconcile people with the topics. Furthermore, providing **tangible information** can address the misperceptions of risks and impacts that might arise from incorrect understanding and calculations (cf. perceptual biases). Here again, communicators have to find a balance between simple and complete information. Although they are urged to keep the messages simple, they should try to maintain a complete picture of the topic. The linkages between the different elements of CC should be clear to avoid inefficient responses, such as the single-action bias. Furthermore, people should not have the impression that they are being manipulated by only showing only one side of the coin, as the control bias can also create defensive mechanisms [13].

Box 4. Examples of balanced and intuitive communication

The ActNow website and the AWorld mobile app provide examples for intuitive messages. First, the action's impacts are provided with simple and meaningful numbers and at familiar scales (e.g. what you avoid through an average daily travelling distance or one daily meal). Then, the website provides fact sheets and information to show the complete picture and explain linkages. Both use eye-catching and lively visuals that quickly transmit the key message.

Finally [one video](#) in support of ActNow gives an example of a lively, relevant, and balanced message where strong images of real events, people, and solutions are shown, and where an emotional voice and music is used.

Simple messages should also be **lively**. Indeed, people tend to react more strongly and instinctively to things they experience and feel rather than sterile and distant information [10, 11] (c.f. experiential processing system). CC-Communication may thus also **target emotions and experiences** to make people feel the urgency of the situation,

and not only *understand* it. Communicators can use **experiential tools** such as story-telling, imagery, virtual reality, and real-world examples [11, 12]. Ideally these tools should try to recall personal experiences such as recent extreme weather events (c.f. make it relevant) [11, 12] to reduce the psychological distance to climate change that we discussed above. Additionally, the communicators should try to tell strong and “new” stories that trigger **emotions**, and show **new social norms** that can catch the attention of people [12]. When using imagery, they can try to use authentic images showing real and expressive people [12]. Generally, they can apply all the present recommendations (e.g. make it relevant by showing an image of a local place) [12].

Making a message lively by creating and recalling experiences and emotions is hoped to trigger the first system of the brain in a constructive way. It is hoped to catch people's attention to a message, so as to potentially overcome the *attentional biases* of people that show less concern for CC. Secondly, it is expected to drive a more accurate risk perception of climate change, i.e. address *discounting*. If people feel that climate change is a threat they might re-evaluate their risk perceptions and the subsequent actions. Finally, it can be a way to trigger powerful emotions that can favour behavioural change.

The rule of balancing the message is very relevant here as both strategies are complementary. First, experiential information should be in combination with more analytical information, as studies show that the change in beliefs and behaviours is more permanent when people have processed and integrated the information. Emotional reactions are strong and motivating in the short term but they tend to fade away with time. In addition, they have pitfalls such as triggering bad coping strategies (single action bias) or defensive mechanisms [10]. People's maintained interest and engagement in CC have higher chances of survival over time if the issue is profoundly understood (such as understanding that it is a long-term and systemic problem).

All in all, **information provision should be balanced in the format by mixing scientific and evidence-based information with a general public approach and emotion-rich storytelling.**

Make CC relevant

The key challenge for climate change communicators is to make climate change relevant to diverse audiences. In psychological terms, making climate change more **relevant** means reducing the psychological distance to the topic - **increasing perceived proximity** (see Figure 11). The audience should feel concerned, engaged, and should understand why climate change is an issue for themselves, and why and how they are associated with it.

Framing is a commonly recommended communication strategy to adapt a message to an audience or a context and thus make it more relevant to a given audience. Framing refers to the way information is conveyed and tailored to emphasise certain aspects, here of climate change, over others. Climate change **issue frames** can target a specific domain such as the economy, health, national security, biodiversity, and agriculture by underlining how these are related to climate change (issue framing). Showing a complete picture, thus using different frames and showing the linkages between these is also a way of making climate change relevant to less concerned people. For example, showing that biodiversity loss is leading to potential agricultural losses rather than leading to some non-human species going extinct can increase concern in audiences that are not particularly sensitive to non-human species. Drawing attention to the health risks of pollution has also been effective to increase public concern about CC [10]. For example, approximately four and a half million people died prematurely in 2018 as a result of exposure to air pollution from fossil fuels, the main driver of climate change, with an average of 19 years shaved off each life. In the same year, fossil fuel pollution was responsible for 1.8 billion days of work missed due to illness, 4 million new cases of asthma amongst children, and 2 million preterm births. The **language** used to talk about climate change is also a way to frame the issue as it refers to different values and principles [14] (e.g. of climate change vs. global warming). Similarly, as we discussed before, the choice of terms can make an issue more tangible to people, and translating scientific terms or data into more concrete terms or units can increase people's interest and concerns. Framing pollution as average deaths instead of microparticles can be an

example to make CC more salient. Framing is mostly used to reduce psychological distance CC by showing that it can affect different aspects of people's lives and overcome the attentional and perceptual biases that arise from people's mental models. Plus, framing can help make CC impacts more concrete to people (less abstract). Using different frames can help to "touch" people with different sensitivities, expertises, and ideologies. It is a way to "enter" in their mental model to then correct their knowledge and perceptions. Important for this is thus to know your audience and their mental model [10], and thus what is important to them.

Most importantly, CCC needs to reduce the perceived temporal, spatial, and social distance to climate change. It should **frame** climate change as a **present, local, tangible, and personal issue** ('a concrete problem affecting me, my loved ones, or my country, now') - and not as it has been framed in the past: a future, geographically distant, impersonal, and analytical risk ('an abstract problem far away and in the distant future')[10, 11]. Studies indicate that picturing climate change as a "close" issue can have a greater impact on increasing concern and willingness to change behaviours among individuals [11]. Therefore, communications should focus on elements that are relevant in the present and geographically close locations. This can be done, by describing consequences that are already *visible* - or that will occur in the very near future. Ideally, messages should use *examples of events and issues* that the audience might have experienced using national and local examples [10, 11] (e.g 2021 droughts or current temperature records²) or by representing people with which audiences can identify (e.g. Swiss inhabitants or personalities, other European countries). Targeting the experiential processing system, by *invoking emotions and senses* (see **be intuitive**) is another way to reduce psychological distance. Communication should try to move away from long-term scenarios describing costs and benefits in the future (e.g 2100) , and far away geographically (e.g polar regions). This is mostly to address discounting of distant events and to correct risk perceptions of climate change. It can also address issues associated with attentional biases, as people might show more interest in information

² <https://www.letemps.ch/suisse/records-chaueur-attendus-cet>

that is relevant to them compared to information that does not directly relate to themselves.

Finally, another approach to reduce psychological distance is by [increasing the identification](#) with CC-messages by adapting them specifically to the respective social contexts [13, 14]. More precisely, it can reduce the social and political distance to CC and increase social normativity (see Figure 11).

Against this background, a first strategy is to [adapt the social norms](#) contained within CC-messages, such that the CC-related beliefs or behaviours are more perceived as normal and desirable and thus *increase familiarity* and social acceptance of CC in a given audience. The goal of communicators can be to make CC part of the social landscape, such that it seems more normal to talk, be concerned about, and act upon climate change (see reduce novelty in Figure 11). If people observe that a significant proportion of the overall population, or of their respective social group (based for example on gender or political identity), is concerned by climate change and performs pro-environmental behaviours, CC-messages might be perceived with more importance. This can be illustrated in stories and images and by making social comparisons, such as describing the beliefs or behaviours of social referents (e.g. neighbours, men/women, SVP supporters) [13].

Furthermore, communication can “tap into social affiliations” to make people [identify with common social goals and values](#) and make CC appear as a relevant threat to these. Using existing communities, social networks, and groups or peer-to-peer approaches is meant to be driving public engagement. For example, city-based programs targeting the identity of a city to encourage pro-environmental behaviours have shown success[10]. Words such as “us” and “we” instead of “I” and “you” can also leverage a common identity and concern [14] (see [box 3](#)). Finally, values are shown to be powerful social triggers and highlighting these in communication can make the message relevant to the audience. History has shown that values of peace, solidarity, and respect can be powerful and lead to individual and collective action. Furthermore, they are not dependent on external incentives and are thus likely to be more stable and durable motivators [11]. A general rule is thus to [leverage intrinsic motivation and values](#) [10] through [appeals](#) or by making people aware of contradictions (cognitive

dissonance). Cognitive dissonance, which means to act in contradiction with one's values, is a common phenomenon - and making people aware of it has been shown to be powerful to change behaviours [32]. Highlighting to an individual acting for social justice that climate change is also going to increase social injustice, and might increase this person's willingness to change their consumption behaviours and/or to extend its collective action to the climatic cause.

Finally, the [relevance of a message](#) can be influenced by the [messenger](#), which can trigger different levels of identification. CC change might be perceived as more important when it is addressed by a messenger with which people trust, identify with and share mental models and values. When a specific social group is targeted, it can be useful to identify social referents, it could be the political institution of a region (government), a recognised member of a political party, a popular artist, a religious representative (pope), a Nobel laureate and so on.

Targeting communication can be a challenge when the audience is not well known or not "controlled". A general recommendation is thus to choose frames that can match the most people (the local frame is efficient for both young and old people) and balance the message between different frames (see also *Balancing the message*). In terms of messengers, it can be interesting to pick into the largest panel of people possible, including young and elder persons, scientists, practitioners and artists, politicians and citizens, with the purpose to resonate with the whole of society.

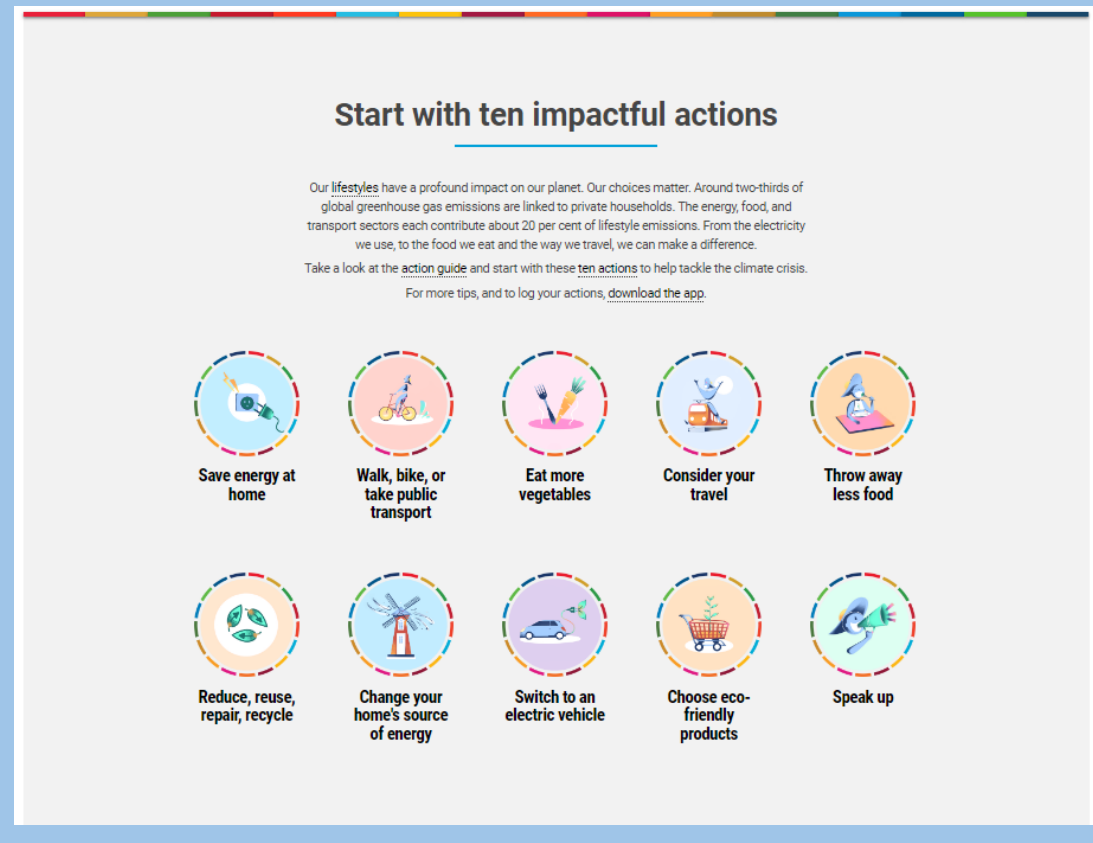
[To sum up, climate change should be made relevant to people by underlining that it is a concrete, current and personal issue, that it concerns people's life as well as endangers common well-being and values.](#)

Show the way

If CC communication aims to trigger behavioural change, it is important that the messages [show the way](#) by communicating about [concrete solutions and providing actionable perspectives](#). The literature identifies several strategies in this regard:

communicating solution-based and optimistic messages, proposing concrete actions and demonstrating behaviours, supporting efficacy perceptions, and facilitating action.

Box 5: Example of concrete and lively communicated individual action



If messages want to be motivators, communicators should try to include **solution-based and optimistic elements** in their messages. These can describe examples of existing solutions, ideally solutions that have been put in place and show success stories. Communication can aim at depicting positive imaginary societies (ex: the ideal city, new democracies, new agricultural systems...). This is especially important to increase policy support and active demand for policies.

Balancing the negative acknowledgments of the causes and consequences of CC with more positive narratives by showing alternative scenarios is a first possibility to avoid an overload of negative emotions leading to defensive mechanisms and disengaging

feelings such as hopelessness. [Telling a new story](#) is a way to make people identify with a desirable future. Here, the positive affect plays an important role as people are expected to favour positive experiences over negative ones, and are thus more likely to identify with a positive future and to give attention to these positive messages. Telling new stories is also a way to change people's perception of the "desirable" social norm, and slowly hope that they adapt their behaviour to it. Finally, the proposed solutions should try to appear as concrete as possible to the individuals by showing solutions that are put in place currently and close to them (or have the potential to), and that have benefits today and for them. It is thus important to make long-term scenarios (e.g 2030) more concrete by showing what changes it requires today, and by providing closer milestones and solutions. Providing concrete solutions and proving their feasibility and their positive impact with evidence is a way to overcome misperceptions with regards to it, notably under a sceptical audience. To avoid the *status quo bias* it can also be reminded which losses might occur if these solutions are not adopted.

Moreover, it is crucial that the potentially strong emotions and reactions triggered by the messages can be transformed into action. Therefore messages should seek to propose an [action perspective](#), meaning very practically giving [descriptive examples of actions](#) that an individual can take at her/his scale, individually, or collectively [13]. Here again, the description of the desired behaviour should be relevant and intuitive: be simple, concrete, applicable, and relevant to the person's social context (see [box 5](#)). A recent example is a website that has been created to help people react after watching the movie "Don't look up"³, which is an analogy to the climate crisis. The website provides a list of actions that individuals can take at their personal level to fight climate change and political inaction. Similarly, Act Now provides a very intuitive action guide through a website as well as a mobile app (see [box 5 & 6](#)). Besides the positive action perspective, it is also important to raise attention on negative or undesirable behaviours to avoid that they prevail beside the new sustainable behaviours and to clarify the message of which behaviours are impactful and sustainable [13]. In the overall goal to favour behavioural changes that drastically fight climate change, communicators can

³ <https://dontlookup.count-us-in.com/fr>

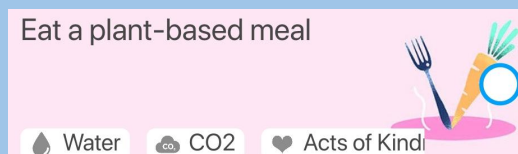
[advocate for high-impact behaviours](#) and not only the ones that are not “painful” to adopt (ex: giving up taking the plane instead of recycling) [14]. This can also be encouraged by providing [clear information on actions impact](#) to counter misperceptions and help individuals focus on behaviours that have the most impact. Furthermore, communicators are urged to [favour systemic behavioural changes](#) by promoting complete and coherent low-carbon lifestyles instead of single-action promotion [14]. This is mostly important to avoid rebound effects/moral licensing of behavioural changes or the single-action bias [10] such as *“I can take the plane because I am a vegetarian so I am doing better than most people anyway”* or *“ I already protect the environment because I recycle”*. Communicators could thus promote principles or mindsets that cover several behaviours such as localism, zero waste, degrowth, and mindfulness.

When providing these action perspectives, it is important to clearly state how the provided examples of actions or lifestyle changes can contribute to climate change mitigation and to [describe tangible effects](#) [13]. This is important to empower individuals and overcome the *low control perception*, i.e. that one has no control over this global process, and the “false sense of inefficacy of individual actions not making an appreciable contribution” to climate change. Both are *perceptual biases* leading to inaction [13, 26]. Control perception can be corrected by providing a clear picture of the interlinkages between daily behaviours and climate change. To support efficacy perceptions, communicators need to give examples of effects that people are able to “grasp”. Using simple language, a relevant scale, and comparisons are ways to make the effect tangible [12] (c.f. [make it intuitive](#)). The example of low-meat diets can illustrate this. Indeed the contribution of low-meat diets to climate change mitigation might be less straightforward to people than reducing car use. The linkages with CO₂ emissions should be explained by describing how reducing meat avoids direct CO₂ emissions of animals and machinery used to produce feed crops but also indirect emissions by slowing down deforestation. Furthermore, providing clear numbers to correct perceptions of footprint [26] can be impactful. For example, a relatively small number of people know that food consumption is the first source of environmental impacts for the

Swiss population (before transportation and housing) and that animal-based products are responsible for 40% of the environmental impacts of food consumption [33].

Box 6: Example of actionable communication

“By replacing one meat-rich meal with a vegetarian meal, you can save about 1.46kg CO2 emissions and over 1000 litres of water”



This example of action is described in the app, in there it is explained how meat production contributes to climate change by referencing credible information sources (*be trustworthy*), it provides clear numbers to make impacts tangible and at scale (*make it relevant and intuitive*), plus they provide concrete examples of alternatives such as a pizza margherita (*show the way*).

Providing [collective action perspectives](#) can also support efficacy perceptions and can thus also be encouraged by communicators. First, communicators can use the collective dimension to show how individual consumption behaviours can [scale up](#) and thereby increase the sense of collective efficacy [[11](#), [12](#)]. Example: “if the whole Swiss population would shift their diets including to divide their meat consumption by three, it would divide Switzerland’s food-related impact on climate change by 2” [34]. It can also be used as a motivator as in the Act Now campaign where people are encouraged to share their efforts: “*Actions are contagious, they can scale up to spur the collective change we need to tackle the climate crisis*”⁴. Then, communicators can also show how political behaviours in the collective sphere can have an [impact on the structural causes](#) of climate change such as the economic system and actors as well as the policy frames [[14](#)]. Communicators should thus encourage policy support but also policy “demand”, thus demonstrating behaviour and collective action behaviours such as political participation, activism, advocacy, non-violent civil disobedience, and boycotts. Again,

⁴ #MyClimateAction <https://blog.agoraawards.com/myclimateaction/>

this should be done by providing clear examples (“you can boycott meat” or vote for “meat-reducing policies such as providing meat-free dishes in schools canteens”).

Box 7: Examples to illustrate the collective dimension

The “Act now” campaign points at the need for - and the power of - scaling up individual action. First, they provide numbers of how many people have taken action already and what potential impact that represents (see left-hand picture). Second of all, one action they suggest to take is to [speak up](#), meaning to advocate for climate action in the private, work, political and corporate spheres.



Balancing the individual and collective dimensions of climate change action can address several defensive mechanisms. As mentioned earlier, the collective dimension can support efficacy perceptions and thereby also remove a paralysing effect of feeling overwhelmed or hopeless. Being honest about the limited impact of certain actions is also considered as important and not necessarily being counterproductive for behavioural change [14]. Acknowledging the limitation of certain actions, does not delegitimize them (ex. recycling) but is an opportunity to underline collective efficacy [11], the power of the mass (if everyone recycles) and thus encourage collective action (general boycotts, political and consumer pressure...) as well as to avoid the “single-action bias” or rebound effects [10, 11].

Furthermore, acknowledging the role of systemic actors such as multinationals, the fossil fuel industry, or political parties can also be a way to overcome certain defensive

mechanisms. For example, it avoids “blaming others” related to a sense of injustice arising from the fact that responsibility is shifted on individuals instead of public authority and large companies. In the case of public communication, this is especially important as the audience has expectations towards the source of the message (*social expectations*). Acknowledging a shared responsibility can thus avoid reactance such as “why should I recycle while industries continue to promote packaging?”. As such, the UN campaign underlines the necessity to *speak up* to world leaders and for change in all sectors by stating “*Concrete steps by global and local leaders will determine our ability to rapidly transition to a climate-resilient future.*”

Finally, communication can also [facilitate or “nudge” action](#) as it has been shown to be an important lever to encourage behavioural change [24, 30]. Although it may not directly actually facilitate behaviour as is the case for [behavioural interventions](#) (see section [4](#)), communication can apply some of the behavioural insights and strategies. The most common barrier to action is still the effort needed to do a behaviour, therefore it can be effective to [reduce the effort](#) and make action the most easily accessible to people. This includes for example a direct link towards an activist group, NGO, or a donation platform, where the least steps toward the action (subscribing or donating) should be needed. Indeed, the effort of seeking the right organisation has been removed. Less directly, communication can [reduce the perceived effort of a behaviour](#). Communication programs encouraging testing behaviours (e.g “bike to work” for one week only) can address the status quo bias, a key barrier to changing habits. Indeed, it can facilitate the “first step” and thereby correct the perceived effort, as people realise that the behaviour is not as unpleasant or difficult to adopt as expected (foot-in-the-door strategy) [35]. Behavioural studies show that behavioural change can also be facilitated by making the *desired behaviour* the [default option](#) [10]. This means that an individual will be more likely to choose the first option she has encountered than change to an alternative option (default effect, status quo bias) [10]. Although communicators cannot influence the decision environment of people (for example making the vegetarian plate the default option in canteens) they can make the sustainable behaviours *appear* as the default behaviour, i.e the “normal” behaviour. In stories or marketing communication, the

more sustainable behaviour can be put on the front scene and be the automatic or “normal” behaviour of protagonists. As an illustration, when a person in a story is deciding to travel, it should be obvious that the first choice is to take public transportation and not a personal vehicle.

In the literature, making **actions appear as pleasant and positive** to someone is also considered as facilitating action, as it removes certain emotional or perceptual barriers. As such, messages can try to make near-term benefits of behaviours visible [10]. Besides near-term benefits linked directly to climate change mitigation, communicators can also highlight so-called **co-benefits** of climate change mitigation such as job opportunities and improved health outcomes [36]. Communicators can use **social incentives**, and non-monetary incentives, to encourage behaviours. For example, by showing that riding a bicycle has economic and health benefits as well as increases people's happiness and sense of pride (warm glow).

Box 8: Examples to facilitate behaviour in CCC

AWorld, the gamified application of the Act now campaign provides an interesting mix of the communication and behavioural intervention toolbox. It is both playing with *informational and educational tools* (tips, stories, facts, lively visuals), and it introduces several *behavioural tools* to encourage action. This includes the step in the strategy of starting with only a few actions or specific challenges, the feedback approach providing direct information about the impact of one's actions, goal-setting strategies where people can engage in new habits, incentives with a point system, as well as social comparison by providing numbers about others actions and encouraging sharing on social media platforms.

Further actual behavioural interventions will be reviewed in section [7](#), and as highlighted here, these can be considered complementary strategies toward pro-environmental communication and behavioural change.

These **five principles** are proposed to **guide communicators** through the potential **barriers to climate change communication**. By creating CC messages that are balanced, relevant to a given audience, intuitive, and trustworthy, and by showing receivers the

way to act upon these messages, communicators should ideally maximise their chance to trigger positive behavioural change. Existing guidelines, summarised in these principles, are thus an important contribution to climate change communicators. However, it is important to note that while the proposed principles are intuitive and theory-based, a systematic evaluation of these approaches is thus far missing. More specifically, no large analysis of specific strategies such as framing, appealing to norms and values, or creating an experience, has been performed. Applying them might thus increase the potential impact of CCC but does not ensure systematic behavioural impact. These limitations - and how to address them - will further be discussed in the summary (section [8](#)). The next section, identifying effective behavioural interventions, is hoped to cover this missing gap towards systematic behavioural change.

7. Review of available meta-analyses evaluating the effectiveness of behavioural interventions

In the previous section, we presented existing guidelines that suggest various climate change communication strategies to address social, psychological, and emotional barriers to behaviour change. While these guidelines provide valuable insights and strategies on how to best communicate climate change, this literature has not yet tested which of these communication strategies works best in a systematic fashion. In other words, no systematic, statistical comparison has been provided so far. Moreover, another major caveat of CCC studies and guidelines is their focus on attitudinal change, rather than behaviour change. In other words, the majority of studies from the academic field of CCC focus on how to change the “hearts and minds” of individuals but seldomly study how to change actual behaviours. Due to these caveats in CCC research, in this section, we present the results of our own systematic literature review of existing meta-analyses on *behavioural interventions*. In contrast

to CCC research, behavioural interventions focus more on how to change actual behaviours (recycling, energy conservation, etc.). As one of the main purposes of this report is to identify effective interventions and strategies facilitating behaviour change, here, we present our results on the state of the art in this area.

Which behavioural interventions facilitate behaviour change?

What does research say about the effectiveness of behavioural interventions in facilitating behaviour change in the context of climate change? Conflicting reports on the effectiveness of behavioural intervention approaches (see Table 2) abound - but meta-analysis can help sort out the overall benefits and weaknesses of these and other behaviour change strategies. In the following, we report on a comprehensive set of these broad meta-analyses that seem to indicate effective- and ineffective behavioural intervention strategies.

In meta-analyses, researchers examine many studies on a particular intervention strategy and derive a numerical indicator of the relative effectiveness of the strategy, averaged across all studies. This indicator is called an effect size (ES) (see Box 9: "How Meta-analysis Works").

Box 9: How meta-analysis works

Meta-analysis aggregates findings across a particular area of research by converting data in each study to a common metric or effect size (ES). The ES is computed by subtracting the obtained mean of the untreated subjects from the mean of the treated subjects and dividing the difference by a measure of the variance in the sample, usually the standard deviation of the controls. An alternative ES uses pretest and posttest data, when no control group has been used. Note that one or several ESs may be obtained from each study, depending on the following:

- Different variations of the intervention studied.
- Number of outcome measures used.

ESs may range from zero (meaning no observable effect) to one or greater and may be thought of as a z score or standard deviation unit, and negative ESs are possible. ESs from each study are then aggregated together to arrive at a mean ES across all studies. This overall mean ES can be correlated with related study variables or subjected to

statistical analyses designed to tease out differences or trends. In reference to Cohen's d ES, values:

- below 0.1 tends to be interpreted as a very small effect,
- around 0.2 a small effect,
- 0.3 –0.4 a medium-small effect,
- 0.5–0.6 a medium effect, and
- 0.7 and above a large effect.

Meta-analysis is a deceptively simple technique, and a growing body of statistical or related procedures is available to guard against misinterpretation of obtained ESs. It should be noted, however, that an overall mean ES (an average of all ESs across all studies in a research area) is usually reported as a way to capture the "effectiveness" of the procedure or intervention being studied [37].

Such an analysis of research not only provides a numerical indicator of the relative effect of a particular intervention, but the effect size also allows comparison with other approaches used in behavioural intervention programs which aim for behaviour change in the domain of climate change mitigation or sustainable behaviours more generally.

Comparing meta-analyses available to date

To find out what research says about the effectiveness of behavioural interventions in facilitating behaviour change, we conducted a systematic database search. More specifically, we performed a literature search using electronic databases such as PsycINFO, Scopus, ProQuest Social sciences, PubMed, and Web of Science. In addition to the electronic database search, we also hand-reviewed existing review papers and searched for meta-analyses on the web using Google Scholar. Our initial database search yielded 18627 publications. After removing duplicates and excluding studies that did not fit our inclusion criteria, we identified 38 papers that fulfilled our inclusion criteria.

The 38 meta-analyses and systematic reviews⁵ we identified analyse one or multiple of the behavioural interventions and strategies (see Table 4). Some of these meta-analyses and

⁵ Systematic reviews are similar to meta-analyses in that they provide a broad overview of research done on a specific research question. In contrast to meta-analyses however, systematic reviews do not work with ES and are thus only descriptive in the sense of summarising all available research.

systematic reviews are quite outdated while others only analyse one type of behavioural intervention instead of comparing different behavioural interventions with each other. Moreover, some of the meta-analyses focus on one domain of behaviour change (e.g., household energy reduction, recycling) while other meta-analyses focus on a broader range of behavioural domains simultaneously. In [Section 3](#) we have already given an overview of the most commonly occurring behavioural interventions.⁶ For convenience sake, we display our findings in this regard again (see Table 2 below). Our systematic literature review yielded 9 broad categories of behavioural interventions.

Table 2: Behavioural interventions for behaviour change

Intervention type	Description
Feedback	This intervention strategy consists of providing individuals or groups with information regarding behaviour change along with a comparison with a predefined standard, so as to show the difference with the standard and motivate them to fill the gap. A widely used example of the Feedback intervention is energy-consumption feedback.
Incentives	Incentives refer to any kind of benefit (e.g., monetary rewards, refund and unit pricing programs, gifts, prizes, lottery tickets, discount coupons, social rewards, and non-monetary benefits, etc.) that participants retrieve from their participation in a behaviour change program. Incentives can be used to increase pro-environmental behaviours such as recycling, energy usage reduction, cycling, etc.
Commitment	In the interventions using commitment, individuals commit to produce a certain behaviour or reach a certain goal. This technique is believed to work due to the

⁶ Note that there is no uniform classification of behavioural interventions and considerable overlap between different types of categories are thus unavoidable. To maximise the uniqueness of each behavioural intervention we found we present a classification here that is based on several previous meta-analyses [23–25] (Osbaldiston & Schott, 2012; Mertens et al., 2021; Khanna et al., 2021) and covers a broad range of the most widely used and researched interventions. This overview is thus not comprehensive in terms of all the existing categories of behavioural and social-psychological interventions described in the academic literature.

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	<p>motivation of the individuals to appear consistent, since inconsistency (e.g., a person says s/he will do something and then does not do it) is commonly viewed as a socially undesirable trait. Commitment interventions can also be employed in a variety of behavioural change domains like mobility, conservation, and consumption. Commitment interventions can be set at the private or public level.</p>
Goal-setting	<p>Interventions in this category try to change psychological processes, such as promoting goal-setting, implementation intentions, or engagement, towards behaviour change. Goal-setting interventions can also be employed in a variety of behavioural change domains like mobility, conservation, and consumption.</p>
Social comparison	<p>These interventions tend to provide a comparative reference with respect to the mitigation behaviours of close others, such as neighbours, colleagues/friends, or fellow citizens, based on social influence and social comparison. These interventions also activate the influence of social norms.</p>
Social norms	<p>These interventions use the influence of social norms to facilitate behaviour change. Individuals may change their behaviour to conform to social norms either as a means to gain others' approval, or/and to act appropriately.</p>
Social modelling	<p>Social modelling interventions include any kind of passing of information via demonstration or discussion in which the initiators indicate that they personally engage in the behaviour. The effectiveness of this type of intervention rests on Bandura's learning theory, which assumes that people learn through observation of the behaviour of others, imitating this behaviour especially when it is relevant, easily understandable, and permits the individual to reach meaningful and positive outcomes.</p>
Choice architecture (<i>Nudging</i>)	<p>Usually designated as <i>nudges</i>, these interventions influence behavior by removing internal and external barriers. Nudges aim at</p>

	<p>facilitating a decision or adoption of mitigation behaviour by removing motivational barriers or physical barriers by altering the structure of the environment in which people make choices (see environmental alterations). Examples are setting default options such as reducing plate/glass size or setting air conditioning by default to higher temperatures. Choice architecture is best understood as an umbrella term that comprises several of the here described interventions such as social norms and environmental alterations.</p>
<p>Environmental alterations</p>	<p>This type of intervention consists of making pro-environmental behaviours more convenient and easy to perform by modifying the physical environment, for instance by increasing the proximity or number of recycling bins, changing their appearance, or providing home equipment for sorting waste.</p>

In Table 4, we have summarised the results of these meta-analyses on behavioural interventions to facilitate behavioural change in the context of climate change and sustainability. The first column (*Reference*) in Table 4 provides an abbreviation for the respective meta-analysis. The full title of the research is provided in the [Appendix](#) and we encourage the reader to consult the provided references in more detail. The second column (*Time-coverage*) indicates the time period covered in which the studies were conducted. The third column (*Dependent variables*) indicates which type of specific behaviour was analysed in the meta-analysis/systematic review. Column 4 (*Behavioural domains*) indicates the larger behavioural domain which was analysed in the respective meta-analysis/systematic review. The fifth column (*Studies/Papers*) indicates the number of individual studies or papers that were reviewed or used in the meta-analysis/systematic review. The sixth column (*Study design used*) indicates the specific research designs (experimental, correlational, etc.) within the respective meta-analysis/systematic review. In column 7 (*Interventions used*), we report which behavioural interventions were considered in the meta-analysis/systematic review. In the eighth and last column (*Effectiveness of intervention*), we report if and which interventions were successful in facilitating behaviour change.

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In the last column of Table 4 (*Effectiveness of intervention*), we indicate the effectiveness of the respective interventions evaluated in each meta-analysis so you can see which strategies are most (or least) effective. This "meta-meta-analysis" provides a summary of the relative power of a variety of behavioural- and other related interventions, at least those to which meta-analysis has been applied thus far. Please note that the *systematic reviews* listed in the Table (see Table 4) do not provide Effect Sizes and are thus not suitable for statistical comparison of intervention methods.

To make the reading of the Effect Sizes more convenient, we have colour-coded the ESs such that:

- **purple colouring** indicates a large ES of a given behavioural intervention;
- **green colouring** indicates a medium ES;
- **yellow colouring** indicates a medium-small to moderate ES;
- **orange colouring** indicates a small ES;
- **red colouring** indicates that the behavioural intervention had no significant effect;
- **black colouring** indicates that no ES were reported due to the analysis representing a systematic review (no statistical effect size) or other technical reasons.

After the overview provided in Table 4, we will summarise the studies individually as well, focusing on those meta-analyses that were comparative in nature and thus enable us to meaningfully speak about the effectiveness of behavioural interventions in comparison.

Table 4: Meta-analyses and Systematic reviews on behavioural and social-psychological interventions

Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
1. Hornik et al., 1995	1968-1994	Consumer recycling behaviour	Recycling	67	Mixed experimental and observational	Extrinsic vs. intrinsic motivators and External vs. internal motivators	No Effect Size: Correlational
2. Ouelette & Wood, 1998	1974-1994	Past behaviour frequency, behavioural intentions, and behaviours	Various non-sustainability behaviours like seat-belt usage, diet, etc.	64	Only observational	None	No Effect Size: Correlational
3. Abrahamse et al., 2005	1977-2004	Household energy conservation: Various	Energy conservation, Electricity, water, gas use; heating, laundry, food, transportation	38	Mostly field experiments. One lab experiment	Antecedent strategies (i.e. commitment, goal setting, information, modelling) or consequence strategies (i.e. feedback, rewards)	No Effect Size: Systematic Review
4. Bamberg & Möser, 2007	1995-2006	Pro-environmental behaviour: Various	Energy, Transportation, Meat, Food waste, Water, Recycling, Policy support; Tourism, Consumption, Environmental activism	46	Mixed experimental and observational	None	No Effect Size: Correlational
5. Graham-Rowe et al. (2011)	since 2000	Behaviour (various car reduction measures)	Mobility (car use behaviours: changes in car-usage, single-occupant car use, distance travelled or mode swap)	69	Experimental	Various (interventions designed to reduce: car use per se or single-occupant car use, distance travelled)	No Effect Size: Systematic Review

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
6. Osbaldiston & Schott, 2012	1980-2011	Pro-environmental behaviour: Various	Recycling, conserving energy, conserving water, and making efficient transportation	87	Experimental	Convenience, information, monitoring, and social psychological processes: Easy, Prompts, Justifications, Rewards, Social Modelling, Cognitive Dissonance, Feedback, Commitment, Goal-Setting	Mixed Interventions: cognitive dissonance, goal setting, social modelling, and prompts average effect sizes: Hedge's $g > 0.60$
7. Delmas et al., 2013	1975-2012	Electricity usage (behavioural)	Energy conservation (electricity, no gas or water)	59	Experimental	Individualised feedback via audits and consulting; Pecuniary feedback and incentives	Feedback Average Treatment Effect: 7,4% Reduced electricity consumption
8. Abrahamse & Steg, 2013	%-2013	Self-reported behaviour or observed behaviour: observations of recycling participation rates or a measurement of actual conservation (e.g. pounds of recycled material, meter readings)	Recycling and conservation	29	Experimental	Social influence approaches: Group goal, Group feedback, Comparative feedback, Comparative feedback social norm information, Public commitment, Peer education, Descriptive social norm information, Block leader, Group Incentive, Diffusion of information, Modelling	Social Influence Intervention average effect size: Hedge's $g = 0.35$
9. Miafodzyeva & Brandt, 2013	1990-2010	Recycling behaviour of householders: recycling of packaging materials (e.g., plastic, glass, metal, paper and carton packaging, newspapers). Recycling of organics & electronic waste.	Recycling	63	Mixed observational and experimental studies	Socio-psychological, technical-organisational, individual socio-demographic and study-specific	No Effect Size: Correlational

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
10. Lokhorst et al., 2013	1976-2010	Environmental behaviour change: water or power use, recycling, transit use, etc.)	Energy conservation, Transportation, Water, Recycling, Consumption	19	Experimental studies	Commitment approaches (commitment only and commitment plus another intervention, and compare these with control conditions)	<p>Commitment only: $r = .27$</p> <p>Commitment plus (e.g., feedback, incentives, persuasive messages): $r = .31$</p>
11. Kiöckner, 2013	1980-2011	PEB: Various (self-reported and factual behaviours)	Energy, Transportation, Meat, Food waste, Water, Recycling, Policy support; Tourism, Consumption, Environmental activism	41	Mixed observational and experimental studies. Mostly correlational	Not necessarily interventions but social-psych constructs related	No Effect Size: Correlational
12. Karlin et al., 2015	1976-2010	Energy Usage	Energy conservation	42	Only naturalistic field experiments	Feedback	Feedback average effect size: $r = .071$
13. Maki et al., 2016	1977-2012	PEB: Various (objective or self-reported, not studies that assessed only intentions or willingness to behave)	Energy, Transportation, Water, Recycling	22	Experimental or quasi-experimental design	Financial incentives: cash, fines or fees, lotteries, contests, coupons, reimbursements or rebates, and tickets.	Monetary incentive average effect size: $d = .36$
14. Nour et al (2016)	1990-2015	Eating behaviour (change in fruit and vegetable intake), observed and self-reported	Diet (vegetable intake)	12	Randomised controlled trials	Electronic and mobile phone-based interventions (gamification)	Gamification average effect size: $d = .22$

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
15. Varotto & Spagnolli (2017)	1990-2015	Household recycling behaviour (different outcome measures such as participation rate, weight)	Conservation	36	Experimental field studies	Information, feedback, incentives, commitment, behaviour modelling and environmental alterations	<p>Environmental alterations: $d = .73$</p> <p>Social modelling: $d = .40$</p> <p>Combined Interventions: $d = .24$</p> <p>Information: $d = .23$</p> <p>Incentives: $d = .21$</p> <p>Commitment: $d = .20$</p> <p>Feedback: $d = .14$</p>
16. Nisa et al. (2017)	up to 2016	Behaviour change (factual): Hotel guest behaviour: towel reuse	Conservation domain (water and energy)	13	Experimental field studies	Environmental appeals, messages prompting commitment for conservation, donations to charity, social norms, and nudges	<p>Nudges: $d = .43$</p> <p>Social norms: $d = .25$</p> <p>Environmental appeals = not effective</p> <p>Messages prompting commitment for conservation = not effective</p> <p>Donation to charity = not effective</p>
17. Bamberg & Rees (2017)	2002-2016	Travel behaviour (self-reported)	Mobility (personal travel behaviour)	11	(Quasi)-experimental	Personal travel planning	<p>Personal travel planning average effect size: $h = .12$</p>

7. Review of existing meta-analyses

Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
18. Wynes et al. (2018)	1991-2018	Behaviour, observed: greenhouse gas emissions reductions associated with behavioural change. Mixed: personal vehicle use, meat consumption, and household energy use	Conservation, Mobility, Consumption	40	Experimental	Various behavioural interventions: Financial incentives, Defaults, Feedback, Nudges, Prompts, Justification, Social modeling, Cognitive dissonance, Commitment, Rewards, Competition, Goal setting	Financial incentives, Defaults, Feedback No effect sizes provided by authors
19. Maki et al., 2019	% - March 2017	PEB: Various (self-reported and objective)	Energy, Transportation, Meat, Food waste, Water, Recycling, Policy support	25	Experimental or quasi-experimental design	Multiple interventions (see SOM) including messaging, incentives, social norm feedback, identity, social modelling, appealing, framing	No Effect Size: Spill-over analysis
20. Reynolds et al. (2019)	2006-2017	Food waste reduction (self-reported, observed: waste weight and visual analysis)	Food-waste prevention interventions at the consumption/consumer stage of the supply chain	17	Studies with applied interventions	Food waste reduction interventions (information-based, technological solutions, nudging, education, and policy/system/practice change)	Nudging: 57% food waste reduction Education: 28% food waste reduction Information: 28% food waste reduction No effect sizes provided by authors

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
21. Nisa et al., 2019	%-June 2018	Factual changes in behaviour: Various	Energy, Transportation, Meat, Food waste, Water, Recycling	83	Only field-experiments	Information, Appeals, Commitment, Engagement, Social comparison, Nudges	<p>Commitment: $d = -.48$</p> <p>Nudges: $d = -.35$</p> <p>Appeals: $d = -.26$</p> <p>Engagement: $d = -.25$</p> <p>Social comparison: $d = -.08$</p> <p>Information: $d = -.05$</p>
22. Bergquist et al. (2019)	1982-2019	Pro-environmental behaviours (measured, no self-reported)	Mixed: conservation behaviour, paper/plastic, mobility, meat	74	Field experiments	Social norms	<p>Social norms average effect size: $d = .32$</p>
23. Badullovich et al., 2020	%-June 2019	PEBs, Beliefs, Behaviours, and Attitudes: Various	CC-related beliefs, attitudes, and affective responses; Attitudes towards CC-related policy; PEB: attitudes, behavioural intentions, and behaviour.	63	Mixed observational and experimental studies. Mostly correlational	Framing techniques (Environmental, economic, etc.)	No Effect Size: Systematic review
24. Sanguinetti et al (2020)	% - 2019	Eco-driving behaviour (fuel economy, emissions, specific driving behaviours)	Conservation (Fuel)	17	Experimental	Feedback (onboard technological feedback, different designs of eco-driving feedback information)	<p>Feedback (Eco-driving): 6,6% fuel economy improvement on average</p> <p>No effect size reported</p>

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
25. Nguyen-Van et al. (2021)	1991-2020	Pro-environmental behaviours and intentions (13 variables)	Pro-environmental behaviours, energy water consumption & conservation, recycling, environmental conservation, environmental program, environmental groups, green consumption, resource extraction, and workplace pro-environmental behaviours	125	Experiments, interviews, survey, census data	Predictors: social incentives (social influence (including internal and external influence); network factors (including network size, network connection, and leadership); and trust (including trust in others and institutions)	No Useful Effect Size: Mixed correlational and experimental data
26. Li & Kallas (2021)	2000-2020	Willingness to pay price premium for sustainability	Sustainable food	80	Choice experiment	Sustainable attributes	No Useful Effect Size: Con-joint experiments
27. Khanna et al. (2021)	No restriction	Behaviour (reduced energy consumption)	Household energy consumption	122	Empirical quantitative studies	Monetary incentives, information, social comparison, motivation, and feedback	Monetary incentives: z = .21 Information: z = .15 Feedback: z = .12 Social comparison: z = .10 Motivation: z = .10
28. Potter et al., 2021	1973-2020	Food choices: selection, purchase, and consumption (actual and hypothetical)	Food consumption	56	Experimental	Labelling (ecolabel) differentiated between information vs claim, presentation format and content type	No Effect Size: Systematic Review

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
29. Reisch et al, 2021	No time restriction but mostly 2015-2019	Actual food consumption behaviour: actual consumption of animal protein or substitutes and/or consumer food waste (and related GHG emissions)	Foodwaste and animal protein consumption	56	Experimental studies, panel studies, interview studies, observational studies. + reviews	Multi-intervention designs: 1) Defaults, 2) Simplification, 3) Use of social norms, 4) Increase in ease and convenience, 5) Disclosure, 6) Warnings, graphic or otherwise, 7) Pre-commitment strategies, 8) Reminders, 9) Eliciting implementation intentions, 10) Informing people of the nature of their own past choices, 11) Priming; 12) Physical or digital micro-environment changes; 13) Other.	No Effect Size: Systematic Review
30. Sánchez et al. (2021)	up to 2021	Sustainable Food Consumption (SFC) behaviours: various	Sustainable Food Consumption, waste, diet, food miles. packaging, production	40	Observational	None	No Effect Size: Systematic Review
31. Grilli & Curtis (2021)	1982-2019	Pro-environmental behaviour (measured outcome)	Conservation behaviours: energy use & efficiency & waste or water usage. Other: sustainability behaviour, climate change mitigation, transport, wildlife cons.	82	Experimental (treatment-control and pre-post)	Education and awareness, outreach and relationship building, social influence, nudges and behavioural insights and incentives	No Effect Size: Systematic Review

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
32. Vesely et al. (2021)	%-2018	Climate-friendly Intentions and behaviours (observed, outcome measure)	Identity & climate-friendly behaviours: energy conservation, purchase of climate-friendly products (e.g., local food products, energy efficient technologies), climate-friendly diet (e.g., eating vegetarian), public transportation use, environmental activism, donations to climate causes, and climate policy support	188	Correlational	predictors: social identity, environmental self-identity, connectedness to nature, and place identity	No Effect Size: Correlational
33. Fischer et al. (2021)	%-2020	Sustainable consumption	Review of approaches of sustainable consumption research	67	Mixed	None	No Effect Size: Systematic Review
34. Douglas & Brauer (2021)	2016-2021	Various pro-environmental: behaviours, attitudes, etc.	sustainability education, energy reduction, transportation, air quality, waste management, and water conservation		Experimental	Gamification (clear progression paths with achievable goals, levels, and rewards, giving players agency over their actions, making use of strategy and novelty to engage players, providing feedback, making use of social comparison or competition, encouraging cooperation between players, or combinations of these principles)	No Effect Size: Systematic Review

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Reference	Time-coverage	Dependent variables	Behavioural domains	Studies/Papers	Study designs used	Interventions used	Effectiveness of Intervention
35. Geiger et al., 2022	2010-2021	PEBs: Various (Behavioural Spillover)	Energy, Recycling, Diet, Water, Activism / Volunteering, Donation, Transportation	29	Experimental (lab and Online), Quasi-Experiments, Natural-Experiments	Framing, Commitment, Structural, (Dis-)Incentives, Information, Feedback, Norms, Requests	No Effect Size: Systematic review
36. Shipley & van Riper, 2022	1988-2018	PEBs: Various (self-reported, observed, behavioural willingness)		30	Correlational and Experimental studies	Pride and Guilt manipulations	No Effect Size: Correlational
37. Kwasny et al. 2022	2001-2019	Consumption-related variables (emotions, attitudes, intentions and other), actual meat consumption, food choice or food sales	Meat consumption	67	Experimental	Interventions addressing personal factors (knowledge and skills, emotions and cognitive dissonance, values and attitudes, habits & tastes), socio-cultural factors (social norms, roles and relationships), external factors (political and economic factors, food environment), single and multi-factors interventions	No Effect Size: Systematic review
38. Composto & Weber, 2022	% - 2021	Household energy demand	Conservation behaviour	554	Experimental	Feedback, reminders, choice architecture, social norms, commitment, nudging,	Nudging Social modelling Commitment Social norms Feedback

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As our main goal here is to find out which type of behavioural intervention is more and which is less effective, in the following, we focus on those meta-analyses that compare different behavioural interventions with each other. In total, we found 8 meta-analyses and 1 scoping review that compared the relative effectiveness of several behavioural interventions thus enabling us to speak of *Intervention A* being more effective in facilitating behaviour change compared to *Intervention B*. Five of the total eight meta-analyses in Table 5 allow us to compare the effectiveness of different interventions (rows 1-5) individually. The remaining three meta-analyses (rows 6-8) evaluate the effectiveness of combinations of interventions thus not allowing us to speak of the effectiveness of individual intervention types.

In the following, we report the results of these 8 comparative meta-analyses. Table 5 summarises the results of these comparative multi-intervention studies.⁷ The first three columns pertain to the behaviour analysed in the given meta-analysis, indicating which Behavioural domain (Column 1), which specific behaviour within this domain (Column 2), and the pro-environmental impact a behaviour change would have in this area (Impact of behaviour: Low, Mid, High). The next eleven columns represent the individual behavioural interventions studied in the respective meta-analysis. The last column (Reference) indicates the reference which can be found in the [Appendix](#). The same effect size interpretation as in the previous table applies: In reference to Cohen's *d* ES, values: below 0.1 tends to be interpreted as a very small effect, around 0.2 a small effect, 0.3 –0.4 a medium-small effect, 0.5–0.6 a medium effect, and 0.7 and above a large effect.

⁷ It is important to note that each meta-analysis uses its own classification of (behavioural) interventions entailing different names for similar intervention types (e.g., engagement vs. goal-setting). Moreover, different meta-analyses use different taxonomies subsuming various behavioural interventions under a broader umbrella category (Engagement = Goal-setting, Commitment, etc.). Therefore, whenever possible, we translated the specific names of interventions as referenced in the respective meta-analysis, to match our own taxonomy of behavioural interventions (see also Table 2 for an overview of behavioural interventions). Moreover, different ES are used in different meta-analyses. While *d*, *g*, and *h* ES are relatively easily comparable with each other, some studies use more tangible measures of effectiveness by reporting the *actual* behaviour change. For example, Reynolds and colleagues (2019, row 5, Table 5) report the percentage of reduced food waste (58% food waste reduction) instead of a classical ES.

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Table 5: Comparative meta-analyses on behavioural and social-psychological interventions

Behaviour			Interventions											Reference
Behavioural domain	Specific behaviour	Impact of behaviour	Feedback	Information	Incentives	Commitment	Goal setting	Social comparison	Social Norms	Social modelling	Choice architecture (Nudging)	Environmental alterations	Mixed interventions	
Conservation	Household Recycling	Low	<i>d</i> = 0.14	<i>d</i> = 0.23	<i>d</i> = 0.21	<i>d</i> = 0.20	-	-	-	<i>d</i> = 0.40	-	<i>d</i> = 0.73	<i>d</i> = 0.24	Varotto & Spagnoli, 2017
Conservation	Water & energy	Low-Mid	-	-	-	<i>d</i> = 0.00	-	-	<i>d</i> = 0.25	-	<i>d</i> = 0.43	-	-	Nisa et al., 2017
Mixed	Mobility, Consumption, Conservation	Low-High	-	<i>d</i> = 0.05	-	<i>d</i> = 0.48	<i>d</i> = 0.25	<i>d</i> = 0.08	-	-	<i>d</i> = 0.35	-	-	Nisa et al., 2019
Consumption	Various household energy consumption behaviours	Low-Mid	<i>z</i> = 0.12	<i>z</i> = 0.15	<i>z</i> = 0.21	<i>z</i> = 0.10	<i>z</i> = 0.10	<i>z</i> = 0.12	-	-	-	-	-	Khanna et al., 2021
Conservation	Food-waste reduction	Low-High	-	28% food waste reduction	-	-	-	-	-	-	57% food waste reduction	-	28% food Waste reduction	Reynolds et al., 2019
Mixed	Mobility & Conservation	Low-High	-	-	-	-	-	-	-	-	-	-	<i>h</i> > 0.60	Osbaldiston & Schott, 2012
Conservation	Household Recycling	Low	-	-	-	-	-	-	-	-	-	-	<i>g</i> = 0.35	Abrahamse & Steg, 2013
Mixed	Mobility, Consumption, Conservation	Low-High	-	-	-	<i>r</i> = 0.27	-	-	-	-	-	-	<i>r</i> = 0.31	Lokhorst et al., 2013

Note. Bolded Effect Sizes indicate the most effective interventions. Moreover, as some of the meta-analyses in Table 5 combine behaviours across different domains with varying behaviours within each domain, the impact of the behaviour can not be accurately reflected. Thus, the column (Impact of behaviour) should only be understood as an approximation.

Varotto and Spagnolli (2017) have compared the effectiveness of Information, Feedback, Commitment, Incentives, Environmental alterations, Social modelling, and Combined interventions in facilitating behaviour change regarding household recycling. Their results show that environmental alterations ($d = .73$) and social modelling ($d = .40$) were the most effective interventions, indicating medium to large ESs. In comparison Information ($d = .23$), Feedback ($d = .14$), Commitment ($d = .20$), Incentives ($d = .21$), and Combined Interventions ($d = .24$) also showed significant effects on increasing behaviour change in regard to household recycling but to a lesser extent than environmental alterations and social modelling. In sum, the meta-analysis by Varotto and Spagnolli (2017) indicates that in regard to [household recycling](#), [Environmental alterations and Social modelling work best](#), while the other interventions resulted in smaller albeit also significant behaviour change.

Nisa and colleagues (2017) have compared the effectiveness of Environmental appeals, Messages prompting commitment for conservation, Donation to charity, Social norms, and Nudges on facilitating behaviour change in regard to towel re-usage in hotels. Their results show that only Social norms ($d = .25$) and Nudges ($d = .43$) were effective interventions, indicating small to medium ESs. In comparison, Environmental appeals, Messages prompting commitment for conservation, and Donation to charity did not show significant effects on increasing behaviour change. In sum, the meta-analysis by Nisa and colleagues (2017) indicates that in regard to [energy and water conservation \(towel re-usage in hotels\)](#), only [Social norms and Nudges facilitated behaviour change](#), while the other interventions did not.

In a second meta-analysis by Nisa and colleagues (2019), the effectiveness of Information, Appeals, Commitment, Engagement, Social comparison, and Nudges on facilitating behaviour change in regard to a broad range of climate change mitigation behaviours (Mobility, Consumption, Conservation, etc.) are compared. Their results show that commitment ($d = -.48$) and nudges ($d = -.35$) were the most effective interventions, indicating small to medium ESs. In comparison Appeals ($d = -.26$), Engagement through goal-setting ($d = -.25$), Social comparison ($d = -.08$), and Information ($d = -.05$) also showed significant effects on increasing behaviour change but to a lesser extent than Commitment

and Nudges. In sum, the meta-analysis by Nisa and colleagues (2019) indicates that [Commitment and Nudges work best to trigger pro-environmental behaviours](#), while the other interventions resulted in smaller albeit also significant behaviour change.

Khanna and colleagues (2021) have compared the effectiveness of Monetary incentives, Information, Social comparison, Commitment, and Feedback on facilitating behaviour change in regard to reduced household energy consumption. Their results show that Monetary incentives ($z = .21$) and Information ($z = .15$) were the most effective interventions, indicating small to medium ESs. In comparison, Feedback ($z = .12$), Social comparison ($z = .10$), and commitment ($z = .10$) also showed significant effects on increasing behaviour change but to a lesser extent than Monetary incentives and Information. In sum, the meta-analysis by Khanna and colleagues (2021) indicates that Monetary incentives and Information work best in facilitating behaviour change in the domain of household energy conservation, while the other interventions resulted in smaller albeit also significant behaviour change.

Reynolds and colleagues (2019) have compared the effectiveness of Information, Choice architecture (Nudging), and Mixed Interventions (policies or systems are altered) on facilitating behaviour change in regard to food waste reduction. Their results show that Choice Architecture had the largest effect by reducing food waste by 57%. Information and Mixed interventions were also effective albeit to a lesser degree by reducing the percentage of food waste by 28% each. In sum, the meta-analysis by Reynolds and colleagues (2019) indicates that Choice architecture (Nudging) was the most effective intervention to reduce food waste followed by Information and Mixed Interventions.

Osbaldiston and Schott (2012) analysed the effectiveness of Mixed Interventions (Prompts, Justifications, Rewards, Social Modelling, Cognitive Dissonance, Feedback, Commitment, Goal-Setting) on facilitating behaviour change across behavioural domains (Conservation and Mobility). Their results indicate a large ES of $h > 0.60$ in facilitation behaviour change. However, due to the combination of interventions and the multitude of behaviours analysed, it is not possible to conclude which specific behavioural intervention or the combinations thereof are more or less effective on which specific behaviour.

7. Review of existing meta-analyses

Similarly, Abrahamse and Steg (2013) analysed the effectiveness of Mixed Interventions (Goal-setting, Feedback, Social norms, Information, Commitment, Education, Information, Incentives, Social Modelling) in combination on facilitating behaviour change in the domain of Conservation (Recycling). Their results indicate a small to moderate ES of $g > 0.35$ in facilitating behaviour change. Again, however, due to the combination of interventions, it is not possible to conclude which specific behavioural intervention or the combinations thereof are more or less effective.

Lokhorst and colleagues (2013) analysed the effectiveness of Commitment and a combination of Commitment plus another intervention (e.g., Feedback, Incentives, Persuasive messages) on facilitating behaviour change across behavioural domains (Mobility, Consumption, Conservation). Their results indicate a small ES of $r > 0.27$ for Commitment-only interventions in facilitation behaviour change. For combined interventions (Commitment plus another intervention), they report a slightly bigger ES of $r > 0.31$. *In sum, Commitment approaches combined with other types of intervention seem to yield larger behavioural change than Commitment approaches alone.* Again, however, due to the combination of interventions, it is not possible to conclude which specific combination of behavioural interventions are more or less effective.

A recent scoping review by Composto and Weber (2022, not displayed in Table 5) summarises a large number of relevant meta-analyses and is worth describing here. Composto and Weber (2022) evaluate 584 empirical papers in total that test the effectiveness of a behavioural intervention to change behaviour associated with household energy demand. Their evaluation shows that the most studied behavioural tools are providing timely Feedback and Reminders and Making Information intuitive and easy to access, followed by (in order) communicating a norm (social norms), reframing consequences (framing), making behaviour observable (social modelling), obtaining a commitment, setting proper defaults (nudging), and transitions and habit disruption. They show that the most studied *demand-side behaviour is electricity use*. Composto and Weber (2022) review the literature to provide further information about which behavioural tools are most effective for specific contexts. According to their scoping review, *behavioural interventions vary greatly in their effectiveness to reduce household green-house-gas (GHG) emissions. Setting proper*

defaults is one of the highest impact behavioural tools, with meta-analyses finding a medium to large effect of defaults on behaviours that reduce energy demand ($d = 0.35 - 0.75$, Jachimowicz et al., 2019; Nisa et al., 2019). Making behaviour observable (Social modelling) and providing recognition has a medium to large effect on energy saving ($d = 0.79 - 1.06$: Nisa et al., 2019; 6-7% energy saving: Handgraaf et al., 2013; Nemati & Penn, 2020; Winett et al., 1979). Obtaining a commitment has a moderate but mixed effect, with significant energy reduction in only half of studies (Andor & Fels, 2018; Iweka et al., 2019; Lokhorst et al., 2013; Nisa et al., 2019). Nisa and colleagues find a moderate average effect ($d = 0.34$) and note that when people accept the goal or commitment that the experiment proposes, the effect size is larger ($d = 0.48$). The relatively small number of studies that examine the impact of reaching out during transitions report mixed results ranging from 3% to 13% energy savings (Mahapatra & Gustavsson 2008, Verplanken et al., 2008, Jack & Smith 2016, Verplanken & Roy, 2016). Meta-analyses of the many studies that study the effect of communicating a norm (Social Norms) find a significant small to medium effect on household energy savings: average percentage savings range from 1.74% to 11.5% (Delmas et al., 2013, Andor & Fels, 2018, Iweka et al., 2019, Buckley, 2020) and effect sizes range from very small to small ($d = 0.08$ to 0.32) (Abrahamse & Steg 2013, Bergquist et al., 2019, Nisa et al., 2019, Khanna et al., 2021). Meta-analyses of timely feedback and reminders interventions find effects that range from 1.9% to 7.7% reduction in household energy demand (Darby, 2006, Ehrhardt-Martinez & Donnelly, 2010, Delmas et al., 2013, Karlin et al., 2015, Nisa et al., 2019, Zangheri et al., 2019, Buckley, 2019, 2020, Ahir & Chakraborty, 2021, Khanna et al., 2021). Reframing consequences in terms people care about has a significant small main effect ($d = 0.20$; Khanna et al., 2021). Making information intuitive and easy to access has a small effect on household electricity use; meta-analyses find average energy savings between 1.8% and 7.4% and very small to small effect sizes ($d = 0.05$ to 0.30 : Delmas et al., 2013, Buckley, 2019, Nisa et al., 2019, Nemati & Penn 2020, Ahir & Chakraborty 202, Khanna et al., 2021). The effectiveness of most behavioural tools is augmented when they are used in the right combination with other tools. Composto and Weber (2022) conclude by recommending that researchers focus future work on high-impact behaviours and the evaluation of synergistic combinations of behavioural interventions.

7. Review of existing meta-analyses

To summarise, our review of existing meta-analyses that tested various behavioural interventions to facilitate behavioural change indicate that many of the presented behavioural interventions show some potential for facilitating behavioural change. However, the effectiveness of a given behavioural intervention (or combinations thereof) largely depend on the specific behavioural domain. Thus, climate change communicators are advised to choose a behavioural intervention which has shown the greatest effectiveness in regard to a specific behaviour. Against this background and based on the presented evidence above, Environmental alterations and Social Modelling work best in facilitating behaviour change in the household recycling domain. In regard to reducing household energy consumption, Monetary incentives and Information provision were the most effective interventions. For energy and water conservation (towel re-usage in hotels) Social norms and Nudges were effective interventions. In regard to a broad range of climate change mitigation behaviours (Mobility, Consumption, Conservation, etc.), Commitment and Nudges were the most effective interventions. Choice architecture (Nudging) was the most effective intervention to reduce food waste followed by Information and Mixed Interventions. Lastly, in regard to household energy demand, Nudging (Defaults) is the most effective behavioural intervention with moderate to large effect sizes, followed by Social modelling, Commitment, Social norms, and Feedback showing small to moderate effect sizes.

8. Concluding remarks

Our review of psychological and cognitive science, as well as of existing climate change communication literature and guidelines, has shown that effectively [communicating climate change](#) requires addressing the abstractness, novelty, and psychological distance of climate change by [reducing the complexity of climate change](#). We have summarised multiple strategies as to how to reduce complexity and increase familiarity and proximity to climate change by a) [making climate change more relevant](#) to a given audience, b) [being more intuitive](#), c) [being trustworthy](#), d) [providing actionable insights](#), and e) [balancing the message](#). We provide concrete and practical examples of how to apply these principles in CCC and how these principles can help communicators address the psychological and behavioural barriers involved in CCC.

While the presented CCC principles are important and useful to maximise the chance of communicators to trigger positive behavioural change, some major limitations have been noted and require additional effort. First, [none of the guidelines on which we base our recommendations are based on a meta-analytical, statistical approach](#). Thus, it is not possible to determine which of the CCC interventions (e.g., framing, appealing, persuasion, information, education) work best. Secondly, most of the CCC literature we reviewed focuses on changing attitudes (e.g., climate change risk perceptions), behavioural intentions (e.g., intentions to reduce individual carbon footprint), and policy support (e.g., support for carbon taxation). Therefore, the [focus of these studies is not on evaluating behaviour change](#). CCC studies focusing on actual behaviours seem extremely rare and thus, it is not possible to determine whether CCC interventions facilitate behaviour change consistently and if so, which CCC interventions work best. Thirdly, another important insight in reviewing the existing scientific literature and guidelines was that most studies were conducted in the USA or other English-speaking countries. Therefore, the results of these studies and the recommendations provided by the existing CCC guidelines originate from a specific social and political context. With this in mind, in order to [improve CCC in other cultural contexts](#)

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such as Switzerland, additional considerations which better reflect the political and cultural specificities of Switzerland might be worth considering. Chief among these considerations is establishing a baseline audience segmentation in order to know the audience and *make CC relevant* to it. For the US context, the YPCCC provides such an audience segmentation which allows classifying the population along with different categories of climate change concerns⁸. Having such an audience segmentation for the Swiss context would help to increase the effectiveness of CCC by allowing the tailoring CCC messages in line with the mental models and levels of knowledge existing in the Swiss context. Fourthly, the reviewed CCC literature has a predominant focus on cognitive factors (i.e., biases, risk perceptions) hindering the effectiveness of CCC. *Research on the role of emotions* in CCC and behaviour change is largely missing still. However, research focusing on positive behaviour change in the health domain (COVID-19, Obesity, Nutrition, etc.) shows the importance of coupling messaging with motivational and emotional information. In this context, some studies indicate that particularly positive emotions such as warm glow or other positive affect can increase perceptions of self-efficacy and thus motivate behaviour change in the climate change and sustainability context [28, 38, 39]. Finally, we have discussed that behavioural barriers can also hinder positive behavioural change, thus limiting the potential impact of CCC, as well designed as it may be. This highlights that actors aiming to facilitate low-carbon behaviours might need to *activate the behavioural interventions toolbox in addition to CCC*, as well as to *make sure that the structural factors are in place* to support the required behavioural changes.

In contrast to CCC research and guidelines, our literature review discovered several meta-analyses investigating so-called *behavioural interventions*. Reviewing these meta-analyses allowed us to *meaningfully compare the effectiveness of several behavioural interventions*, thus to orient actors towards the tools that maximise behavioural change. To start with, our review of existing meta-analyses shows that the effectiveness of behavioural interventions is highly contingent upon the specific behaviour which requires changing. Based on the presented evidence presented in Section 7, *environmental alterations* and *social modelling* seem to work best in facilitating behaviour change in the *household*

⁸ Yale Climate Opinion Maps 2021: <https://climatecommunication.yale.edu/visualizations-data/ycom-us/>

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recycling domain. In regard to reducing household energy consumption, monetary incentives and information provision were the most effective interventions. For energy and water conservation (i.e., towel re-usage in hotels) social norms and nudges were effective interventions. In regard to a broad range of climate change mitigation behaviors (mobility, consumption, conservation, etc.), commitment and nudges were the most effective interventions. Lastly, in regard to household energy demand, nudging (defaults) is the most effective behavioural intervention with moderate to large effect sizes, followed by social modelling, commitment, social norms, and feedback showing small to moderate effect sizes. As shown throughout the report and with the example of the AWorld application, some of these behavioural interventions (e.g., Social norms, Commitment, Social Modeling) are complementary tools to CCC tools. In sum, our review of existing meta-analyses and systematic reviews of studies that tested various behavioural interventions to facilitate behavioural change indicate that many of the presented behavioural interventions show potential for facilitating behavioural change.

To summarise, in this academic synthesis report, we drew on the latest scientific and academic literature on climate change communication guidelines as well as on experimental psychological and behavioural intervention studies to present the state of the art of available tools and strategies to communicate climate change in order to facilitate individual behaviour change. Our results show that CCC can be designed according to five principles to maximise its impacts but that it cannot ensure systematic behavioural change. On the other hand, several behavioural interventions show promising effectiveness to facilitate behaviour change to some extent. However, many of the behavioural interventions focus on low to moderate level impact behaviours. As we have illustrated throughout the report, misunderstandings in the relative efficacy of different pro-environmental behaviours prevail and have important consequences for climate mitigation efforts [22]. In turn, it is important to underline that the precondition to impactful behavioural change is to educate the public about the differential impact of various behaviours in order to maximise the outcome of behaviour change-focused CCC. In this sense, the promotion of large-scale, systemic, and high-impact behaviours is of great interest to climate change communicators. This requires effective CCC and BIs to promote behaviours that are more effective and that target structural causes through active

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policy demand, protest, or consumer pressure via boycotts - as well as individual carbon-footprint reduction via decreased flying and car-driving, or meat consumption.

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Appendix

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