Climate Change and Six Americas: What Can Behavior Analysts Do?

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Abstract

Climate change, directly impacted by human behavior, has been investigated and evaluated across disciplines. The Six Americas was developed as a segmentation tool to communicate effectively with the United States population about climate change (Leiserowitz et al., 2021) across a spectrum from those likely to act in opposition to climate change mitigation strategies to those actively seeking to remediate the climate change effects. Behavior analysts offer unique skills to intervene at the individual level effectively. Behavior analysts will benefit from learning about this conceptual model and its tools, particularly to inform intervention across the spectrum of the Six Americas. This paper will cover a background of the Six Americas and suggestions on how to intervene for these different segments at the individual level, followed by a brief review of the existing effective literature, particularly regarding changing behavior in the food, energy, and transportation sectors. Specifically, behavior analytic interventions will be suggested for a population concerned about climate change who may also be posed for action. Finally, we will provide suggestions to guide behavior analysts to intervene with those disengaged or actively dismissive of the threats posed by climate change.

Keywords Climate change · Six Americas · Sustainability · Pro-environmental behavior

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Introduction

The debate on climate change is settled, with a consensus that the Earth has gotten warmer in the past 50 years (Chance & Heward, 2010; Pörtner et al., 2022). The global temperature has resulted in a mean increase of 1 °C above pre-industrial levels (Pörtner et al., 2022). This anthropogenic warming has largely been a result of the increase in greenhouse gas (GHG) emissions (i.e., carbon dioxide (CO₂), methane, nitrous oxide, and other GHG) resulting from human activity over the twentieth century (Pörtner et al., 2022).

Humans consume more resources than can be regenerated by the Earth within a year. Earth Overshoot Day marks the date when humanity’s demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year. It has been calculated since 1970, at which point it was December 30th, and has fallen earlier each year except for 2020. In 2022, it was on July 28th (Earth Overshoot Day, n.d.-a). Furthermore, high-income countries consume more natural resources than low-income countries (IRP, 2019). As such, Earth Overshoot Day is also calculated by country. For example, the United States’ Earth Overshoot Day was calculated for March 13, 2022, whereas Jamaica utilizes the least resources and fell on December 20th (Earth Overshoot Day, n.d.-b). Therefore, the main focus of this paper will be on wealthy countries, particularly the United States, which is responsible for significantly higher GHG emissions.

The threat to our present and future is real (Pörtner et al., 2022). However, immediate actions can lessen the effects of climate change (known as mitigation) and build resilience to reduce the impact on future generations’ health (known as adaptation; Pörtner et al., 2022). Moreover, many of these actions can simultaneously yield benefits for health, the environment, the economy, and society (Pörtner et al., 2022). As such, there is an urgent need for behavior analysts to use the tools of our trade to reduce the current burden of climate change on humans and prevent future threats (Heward & Chance, 2010) at the micro- and macro-levels (i.e., at the individual level and larger scale or population level, respectively; Alavosius et al., 2015; Alavosius & Houmanfar, 2020; Biglan, 2016). Successful climate change mitigation and adaptation strategies will require aggressive efforts from every profession. Taking action is the next step (Caggiano, 2021).

Successful application of effective mitigation and adaptation strategies will result in enormous changes in behavior related to the consumption of natural resources. Specifically, behavior interventions must reduce the overconsumption of the planet’s resources and influence sustainable consumption patterns of individuals and communities, particularly in the United States. If behavior analysis is going to create effective climate change interventions, wide-scale implementation is needed and quickly.

Knowing the Target Population: the Six Americas

We believe Six Americas offers a foundation for tailoring interventions to individuals. The Six Americas is a segmentation of the United States population based on survey responses about global warming regarding reported beliefs, behaviors, policy
preferences, and engagement on issues (Maibach et al., 2011). Yale and George Mason University researchers developed this tool in 2008 and have tracked survey responses twice a year to establish effective, focused campaigning and governmental and non-governmental organization communication around climate change (Leiserowitz et al., 2021). The initial tool was a 36-item survey (Maibach et al., 2011). It has also been developed into a readily available four-question survey known as the Six Americas Short Survey, Yay! (SASSY!; Chryst et al., 2018; available at https://climatecommunication.yale.edu/visualizations-data/sassy/). In the publicly available SASSY!, respondents self-rate across a Likert-type scale in the areas of importance of climate change to one personally, how worried one is about climate change, how much one believes one will be harmed personally by climate change, and the harm of climate change to future environments. The respondent is placed into one of six distinct groups based on their responses.

The six distinct groups, Alarmed, Concerned, Cautious, Disengaged, Doubtful, and Dismissive, differ across a range of beliefs about global warming or climate change (current group demographic information is available, see Leiserowitz et al., 2021). Taylor et al. (2018) summarized Roser-Renouf and colleagues’ (2014) descriptions of the six categories (see Taylor et al., 2018, p. 218, Table 1). In a brief overview, the Alarmed group believes the scientific community’s consensus that global warming is real and is impacted by human behavior. This group is the most concerned and the most involved. Those who are less concerned than the Alarmed group but still believe the scientific community are categorized as Concerned; however, they are less likely to be involved and view the threats posed by global warming as less imminent. The Cautious group believes that global warming is occurring but does not think it will harm them or future generations. The Disengaged group does not think about global warming and is unaware of the information and the scientific consensus on climate change. As such, they are not involved in mitigation efforts. The Doubtful group either believes global warming is part of the planet’s natural cycle or is doubtful that global warming is a threat. The final group, labeled as Dismissive, is certain that global warming is not real (Roser-Renouf et al., 2014; Taylor et al., 2018). Two groups on the opposing ends of the spectrum, the Alarmed and the Dismissive, are the least likely to change their opinions and believe that they do not need more information to form an opinion (Roser-Renouf et al., 2014). However, the composition of these groups is not static.

Since the initial 2008 surveys, there have been changes in the percentage of the population that falls within each group. Initial surveys yielded that the largest group was categorized as Concerned (31%), followed by Alarmed (17%), Cautious (16%), Disengaged (15%), Doubtful (10%), and then Dismissive (9%; Leiserowitz et al., 2021). Data, as of 2021, indicated that the Alarmed group was the most rapidly increasing group, comprising 33% of the population; the Concerned group comprises 25% of the population (Leiserowitz et al., 2022). This suggests that 58% of the population is informed about climate change and may be more likely to take action. In contrast, the Doubtful and Dismissive groups have been shrinking in recent years (a decrease of 4% since 2017) and currently comprise 19% of the population (i.e., 10% and 9%, respectively), although similar to 2008 levels. The changing categorizations are promising because this suggests that the United States’ population is
increasingly aware of climate change. However, this does not mean it will translate to increased climate mitigation behavior.

Six Americas respondents answered what question they would most like posed to a climate scientist (Roser-Renouf et al., 2014); these responses can inform behavior analysts. Their answers were categorized as seeking information about evidence, causes, consequences, and actions. Information about evidence, causes, and consequences can be viewed as educational, whereas information about actions may be

| Sector                          | Target behavior                        | Target direction | Level of Intervention |
|---------------------------------|----------------------------------------|------------------|-----------------------|
| Food                            | Wasting food                           | decrease         | X                     |
|                                  | Eating plant-based food                | increase         | X                     |
|                                  | Clean cookstove use                    | increase         | X                     |
|                                  | Composting                             | increase         | X                     |
| Agriculture and Land Management | Adding silvopasture                    | increase         | X                     |
|                                  | Planting tropical staple trees         | increase         | X                     |
|                                  | Tree intercropping                     | increase         | X                     |
|                                  | Restoring farmland                     | increase         | X                     |
|                                  | Managing grazing                       | increase         | X                     |
|                                  | Producing rice with low- methane method| increase         | X                     |
|                                  | Conservative agriculture use           | increase         | X                     |
|                                  | Fertilizer use on farms                | decrease         | X                     |
|                                  | Using energy/water-saving farm irrigation| increase         | X                     |
| Transportation                   | Electric vehicle use                   | increase         | X                     |
|                                  | Using rideshare                        | increase         | X                     |
|                                  | Using mass transit                     | increase         | X                     |
|                                  | Using tele-conferencing                | increase         | X                     |
|                                  | Hybrid vehicle use                     | increase         | X                     |
|                                  | Using bikes/creating bike infrastructure| increase         | X                     |
|                                  | Walking/creating walking infrastructure| increase         | X                     |
|                                  | Electric bike availability/use         | increase         | X                     |
| Energy or Materials              | Installing rooftop solar panels        | increase         | X                     |
|                                  | Using solar water heating              | increase         | X                     |
|                                  | Using methane digesters                | increase         | X                     |
|                                  | Using energy-efficient lighting        | increase         | X                     |
|                                  | Using smart thermostats                | increase         | X                     |
|                                  | Recycling                              | increase         | X                     |
|                                  | Installing micro wind turbines         | increase         | X                     |
|                                  | Water use in the home                  | decrease         | X                     |

This table is adapted from Williamson et al.’s (2018) thirty solutions for reducing GHG emissions across four economic sectors.
considered seeking interventions to mitigate climate change. All groups, except Dismissive, had questions categorized across all four areas. The Dismissive group, not surprisingly given their denial of climate change, did not have questions categorized as consequences or actions. This group had questions on evidence followed by causes. Once again, it is important to note that the Dismissive group reported that they did not need any more information to form an opinion and were not likely to change their opinion about climate change. The Doubtful group’s questions were concentrated primarily on causes followed by evidence. Further, the Doubtful group is more likely to be persuaded by individuals within the Dismissive group (Roser-Renouf et al., 2014). In addition, both the Doubtful and Dismissive groups reported that they did not want to read or hear about the issue of global warming (Roser-Renouf et al., 2014). However, Roser-Renouf et al. suggest “that communicating about climate change in more value-congruent ways may increase engagement” (p. 27). The Alarmed and Concerned groups overwhelmingly responded to wanting information about actions. The Cautious group was somewhat evenly divided amongst evidence, causes, and actions, whereas the Disengaged group was reported to pose questions about evidence followed by consequences, causes, then actions. Overall, the Alarmed and Concerned groups may benefit from knowing what to or how to change, whereas the Cautious and Disengaged group may require educational support before moving toward action, and the Doubtful and Dismissive may require actions or information that are directly tied to their values.

In summary, the Six Americas research focuses on communication and messaging; however, changing human behavior is required to mitigate the effects of climate change. Academic settings and other climate change drivers (Hanus et al., 2018; Neumann et al., 2022; Taylor et al., 2018) have adopted the Six Americas approach. In addition, numerous climate change influencers (e.g., government agencies, not-for-profit organizations, private corporations, the news, and media; Campbell et al., 2020) use the Six Americas to target audiences and tailor their work and communication content for climate change interventions. Finally, behavior analysts may benefit from using this framework. The SASSY! tool is free, quick, and easy to administer. Behavior analysts can use this tool to categorize individuals within the Six Americas and proceed with change strategies aligned with the categorization, which we will outline in the following sections.

**Behavior Analysis and Climate Change**

Applied behavior analysis (ABA) has the technologies to inform, incentivize, influence, and motivate individual, institutional, and public audiences to recognize the threat of climate change and promote significant behavioral changes toward solving this existential threat (Williamson et al., 2018). This is not new information as research in this area has been published in behavior analytic journals in the last 50-year span, with an increased interest in the past 5 years (Gelino et al., 2021). In addition, special sections of peer-reviewed journals, such as the present one, have been dedicated to this effort (e.g., Heward & Chance, 2010). However, climate change continues to present both a challenge and an opportunity for behavior analysis to rise to the occasion. As such, we...
believe it is important to provide practical suggestions to impact reducing GHG emissions directly.

It is not challenging to know where to begin. It is well known that the main contributing activities to GHG within the United States are transportation (27%), electricity (25%), industry (e.g., burning fossil fuels for energy or developing raw materials into goods; 24%), commercial and residential (e.g., producing heat or handling of waste; 13%), and agriculture (e.g., livestock; 11%; Environmental Protection Agency, n.d.-c). Further, Williamson et al. (2018) identified 30 behavioral solutions for climate mitigation across four areas (i.e., food, agriculture and land management, transportation, and energy), which we will refer to as the Big Four. ABA can advance research for these Big Four. We will provide direction toward possible intervention at a suggested level (Table 1).

We recommend approaches across the Six Americas categories. No action is too small, especially when taken by millions. Individual interventions can have a collective effect, which could be captured by measurements of CO₂ emissions at the population level (see Bonner & Biglan, 2021, for a model for multisector community interventions). Specifically, we believe behavior analysts can provide interventions starting at the individual level for food consumption (i.e., food waste, plant-rich diets, and composting), energy use (e.g., decreasing electricity use and recycling), and transportation (e.g., using rideshare, using mass transit, using bikes, and walking). It is most important to do something. If the Six Americas is correct, the Alarmed and Concerned groups may be the most likely to take action and, as such, could serve as the targeted population for interventions actively working to decrease GHG emissions. We will primarily focus on targeting the Alarmed and Concerned groups; we will also provide some suggestions for the Cautious and Disengaged groups as well as the Doubtful and Dismissive as another group.

**What Can Behavior Analysts Do for the Alarmed and Concerned?**

Behavior analysts can begin by referencing the extant behavior-analytic research. Gelino et al. (2021) reviewed several peer-reviewed behavior analytic journals and yielded 50 articles targeting sustainability. As related to the 30 behavioral solutions, these studies targeted the food sector (i.e., composting), the transportation sector (e.g., efficient driving behavior [i.e., miles per gal and tire pressure] and decreased driving [miles driven and carpooling]), and the energy sector (e.g., recycling, reusable dishware, kWh usage, thermostat use, lights off, and average device usage). There has been limited research published within those journals since Gelino and colleague’s review (i.e., Atkinson et al., 2022; Newsome et al., 2021). However, this does not cover all behavior analytic sustainability research. Behavioral interventions have been published outside traditional behavior analytic journals (e.g., DeLeon & Fuqua, 1995; Kim et al., 2005; Wang, Shreedhar, et al., 2022a) and used in coordination with other psychological approaches (e.g., Aitken et al., 1994; Kallbekken & Saelen, 2013; see Composto & Weber, 2022; Grilli & Curtis, 2021; Harguess et al., 2020; Kwasny et al., 2022; Wynes et al., 2018 for reviews). The behavior analytic approaches fall within the categories
outlined by Gelino et al. (2021), which include incentives, feedback, punishment, prompting and education, response, effort, self-monitoring, modeling, and commitment and goal setting. Behavior analysts can also look toward some research on community-based social marketing that compares different strategies used within behavior analysis (e.g., prompts and incentives) and considers benefits and barriers (see McKenzie-Mohr & Schultz, 2014; Schultz, 2014).

**Food Sector** The food sector includes the food we eat, how it is cooked, and its disposal, which all impact GHG emissions (Edenhofer et al., 2014). According to Williamson et al. (2018), global adoption of reducing food waste could plausibly reduce CO₂ emissions by 70.5 Gigaton (Gt), and adopting a plant-rich diet can further reduce CO₂ emissions by 66.1 GtCO₂ (i.e., one billion metric tons of CO₂). For reference, a typical gas-powered passenger vehicle emits 4.6 metric tons of CO₂ annually (Environmental Protection Agency, 2022a). As such, the two solutions of modifying what we eat and how we dispose of it are the most impactful for climate mitigation as compared to Williamson et al.’s other solutions. Unfortunately, behavior analytic research in the food sector area is sparse, though there are some exceptions (i.e., Sussman & Gifford, 2013; Szczucinski et al., 2020). Nevertheless, we believe that behavior analysts can expand known effective interventions to this area.

Adopting a plant-based diet is considered a long-hanging fruit for reducing GHG emissions. Animal agriculture releases methane and nitrous oxide, which traps about 25 times and 300 times more heat than CO₂, respectively (Environmental Protection Agency, n.d.-b); the cooking practices for animal-based food emit higher levels of GHG than those of plant-based food (Frankowska et al., 2020). Given that Americans consume meat above the national Dietary Guidelines (Zeng et al., 2019), shifting to a 100% plant-based diet may be challenging. While this area has been researched (e.g., Harguess et al., 2020), behavior analysts have not targeted it.

Behavior analysts have many opportunities for effective intervention in this area. They may want to utilize shaping procedures to reduce animal consumption. For example, promoting Meatless Mondays may allow an individual to contact reinforcement by learning to prepare and consume alternative plant-based meals that may replace animal-based meals and decrease consumption of animals and animal byproducts (e.g., eggs and milk) over time. In addition, meat consumption is decreased when a vegetarian meal is the default option or when a default serving size is provided (Wynes et al., 2018). Procedures, including stimulus equivalence, have targeted identifying accurate portion sizes (Hausman et al., 2014, 2017; Regan et al., 2018; Trucil et al., 2015; Vladescu et al., 2021). These procedures can be utilized at a household level to reduce portion sizes to the recommended serving. Further, behavior analysts can work with individuals using common self-management strategies that have been used with other populations (e.g., autism; Erhard et al., 2022) or organizational behavior management (Ferguson & Rivera, 2022). This can include targets, such as meal planning for nutritionally well-balanced meals and purchasing readily available fruits and vegetables. This may reduce response effort (Friman & Poling, 1995), making fresh produce a more likely choice. Behavior analysts can also refer to Rafacz (2019) for an overview of behavior analytic research promoting healthy food selection. However, shifting from an omnivore to a plant-based
diet is only one step as the decomposition of wasted food contributes to GHG emissions, particularly by way of methane.

In the United States, an estimated 30% of food is thrown out yearly (United Nations Environment Programme (UNEP), n.d.). This is of particular concern because “about half of the water used to produce this food also goes to waste since agriculture is the largest human use of water” (United Nations Environment Programme, n.d.). One such reason for food waste is inaccurate knowledge of food labeling dates (Yu & Jaenicke, 2020). For example, consumers will waste food when it has reached the “best by” date, confusing it with the “use by” date. In such a case, describing these differences may be the only needed step. However, if a prompt is required, behavior analysts can consult the most updated Food and Drug Administration standards (U.S. Department of Agriculture Food Safety and Inspection Service, 2019). In such cases, we recommend a written prompt, similar to the date labeling, placed on the consumer’s refrigerator where it is likely to be most applicable and relevant to the consumer. Food waste also results from over-purchasing items, improper storage, and disposing of edible food due to its visual appearance. As stated, the EPA suggests meal planning to decrease purchasing excess food. They also provide tips on best storage practices and alternative recipes (Environmental Protection Agency, 2022b).

Behavior analysts should start with an assessment similar to the Performance Diagnostic Checklist (PDC; Austin, 2000). The questions could be adapted to the following: Does the consumer know how to store items properly/make the alternative recipe? Do they need reminders to store items/make alternative recipes? Do they have sufficient materials for storage or food preparation? Do they need feedback on storing items/recipe preparation? Do they see the effects of this? Is this too effortful or difficult for them? Finally, do other tasks take precedence over these tasks? Responses to these questions can inform behavior analysts on the best step to proceed with intervention.

Interventions informed by the PDC-HS include training, task clarification and prompting, resources, materials, and processes, and finally, performance consequences, effort, and competition (Carr et al., 2013). For example, if consumers can accurately report how to appropriately store items and identify alternative recipes (e.g., use an overripe banana for bread or a smoothie), behavior analysts should assess further. The behavior analyst can ask to look at stored items or have the consumer demonstrate how they would make a recipe. The behavior analyst can also assess if the consumer has the necessary materials. If all these skills are present, the behavior analyst can determine how to modify response effort, apply reinforcement, or provide feedback. Feedback will be discussed further. However, it is worth noting that Wang, Shreedhar, et al. (2022a) found that in reducing food waste, pro-environmental feedback was more effective than no feedback but not as effective as anthropomorphized feedback. This will need further research.

It is important to acknowledge that not all food waste can be avoided. Furthermore, if food waste goes to a landfill, it decomposes anaerobically and produces methane. It is best, in that case, to divert from landfills through composting.

Composting enables the conversion of organic waste into stable soil carbon without generating methane; the converted organic waste can then be used as fertilizer to
improve soil health while further sequestering carbon (Lou & Nair, 2009). If all countries reached the composting rates standard in the European Union (i.e., 57% of all organic waste), there would be a significant global reduction of municipal waste-generated methane by 2050 (Hawken, 2017). People report not composting because they do not have enough space (Statista, 2022b); however, consumers can compost indoors using vermicomposters, aerobic composting, or an electronic composter (e.g., Meade, n.d.). Many more resources are available through an online search. Behavior analysts could promote and reinforce sustainable composting solutions that convert biodegradable waste (e.g., food scraps and plant material) into soil fertilizer instead of sending it to landfills.

Limited behavior analytic research has been conducted on composting. It generally targets a community level, which behavior analysts may feel is out of reach. However, the interventions and measures can be used at the individual level. For example, Szczucinski et al. (2020) effectively utilized procedures similar to those used to promote recycling to increase composting and decrease contamination. These procedures targeted decreasing response effort by manipulating the distance to the receptacle (e.g., Brothers et al., 1994; Ludwig et al., 1998; O’Connor et al., 2010), clearly distinguishing the receptacle (e.g., Austin et al., 1993), and posting signage that indicates what can be included or should be excluded (e.g., Andrews et al., 2013). Similar to recycling, reduced effort increases the likelihood of composting (DiGiacomo et al., 2018). These interventions, bin placement and signage, could be used separately or in conjunction. Behavior analysts can manipulate the placement and types of receptacles to identify optimal individualized variables. Further, individuals are more likely to compost if they observe others composting (Sussman & Gifford, 2013). Therefore, behavior analysts should model and reinforce this behavior when observed at the household and community level (e.g., in restaurants and public places).

**Energy Sector** Carbon emissions from the energy sector are expected to at least double by 2050 in the business-as-usual scenario (Edenhofer et al., 2014). As such, there is an emphasis on developing city-wide interventions to mitigate climate change (Castan Broto & Bulkeley, 2013). For example, most of the largest metropolitan areas have a program focused on Low-Income Energy Efficiency Program Plus (LEEP Plus), saving electricity by 7% in the winter and summer months (Hancevic & Sandoval, 2022). While behavior analytic research in sustainability has been limited, energy is the most researched area, particularly concerning decreasing electricity use and increasing recycling on the individual level. Common interventions include education, prompting, goal setting, modeling, feedback, incentive, rewards, and product review (see Gelino et al., 2021 for more detail). In addition to recycling and decreasing electricity use, including efficient lighting and smart thermostats, behavior analysis can also advance research and practice on other important energy targets, such as water use, as well as expand to a larger scale, such as city-wide interventions.

Wastes such as metals, plastic, glass, and other materials are now generated faster than any other environmental pollutant, including GHG (Hoornweg et al., 2013). These are categorized as solid waste. The EPA identifies solid waste as “any garbage
or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and community activities” (Environmental Protection Agency, n.d.-d). In 2018, the United States created approximately 292 million tons of municipal solid waste daily, an increase of 231.9% from the 88.1 million tons of municipal solid waste recorded in 1960 (Environmental Protection Agency, n.d.-b). Effective waste management strategies, such as waste reduction, diversion, and reuse can reduce emissions by saving the energy needed to process waste and manufacture new materials (Environmental Protection Agency, 2021).

Behavior analysts can promote recycling all materials, including paper, metal, plastic, and glass. Recycling is an energy-efficient behavior, resulting in less water wastage (Franklin Associates, A Division of Eastern Research Group (ERG), 2018). Ten of the 50 articles reviewed by Gelino et al. (2021) focused on recycling (i.e., Austin et al., 1993; Brothers et al., 1994; Fritz et al., 2017; Geller et al., 1977; Jacobs et al., 1984; Keller, 1991; Ludwig et al., 1998; Miller et al., 2016; O’Connor et al., 2010; Wittmer & Geller, 1976). Six of these counted the number of recyclable items in a recycling bin, trash bin, or both to assess the effectiveness of their intervention. These items are easy to measure as they result in a permanent product. In addition, Bolanos et al. (2020) showed promising results in establishing accurate responding in a sorting task for recycling, trash, and compostable materials that caregivers reported generalizing to the home setting. Accurate sorting of materials could be extended to naturalistic stimuli or other settings. Behavior analysts can reference the studies mentioned above for suggestions on measurement and intervention for recycling.

As mentioned, behavior analysts have focused on decreasing electricity (i.e., 17 of the 50 articles reviewed by Gelino et al., 2021). Much of this research may seem inaccessible to the practicing behavior analyst as it may require usage reports (i.e., utility bills), costly materials, or long participation that fluctuates across meteorological seasons. It is likely that those within this Six America category, Alarmed and Concerned, would have adopted energy-efficient lighting, as adoption has increased within the past two decades (Dreyfus & Gallinat, 2015). Adopting light-emitting diodes (LED) in residential use can reduce emissions by 7.8–8.7 gigatonnes of CO₂ equivalent (GtCO₂ eq) over this time (Hawken, 2017) compared to conventional lighting solutions (e.g., compact fluorescent lamps, halogen lamps, and incandescent lamps). While LED bulbs have a higher upfront cost (about 5 times more), they last about 20 times longer and use about 7% of the energy than an incandescent lightbulb (Eartheasy, n.d.). In addition, consumers can purchase smart lightbulbs and set and control lighting remotely. As a result, consumers will pay less overall by switching to more energy-efficient solutions (Attia et al., 2017; Vanage et al., 2022). Of course, natural lighting should be promoted where possible because utilizing natural light does not produce GHG. As such, it is possible that additional interventions, such as prompting and feedback, will be needed.

Feedback has been a well-researched effective intervention for the reduction of electricity use. Hayes and Cone (1977) examined the effects of monthly feedback in reducing use. This has since been extended and modified by other researchers.
looking to make an impact in the area of sustainability at the individual level, within college dorms and applied to a widespread consumer level (Bekker et al., 2010; Gelino et al., 2021; Hayes & Cone, 1981; Winett et al., 1982). Feedback in the form of social comparisons has increased as the energy sector continues to look for ways to reduce electricity usage. For example, many energy companies across the United States implement a monthly home energy report comparing energy use to surrounding households. Ayres et al. (2013) analyzed the use of home energy reports as feedback to consumers and found that energy use decreased on average by 2%; additional studies have found similar effects (Allcott, 2011; Costa & Kahn, 2013). However, this feedback does not strictly adhere to behavior analytic principles that suggest that immediate and accurate feedback is the most effective (Karlin et al., 2015).

With technological advancements, the emergence of smart devices has provided immediate and accurate feedback opportunities. For example, behavior analysis can promote smart thermostats, which are devices that reduce heating and cooling demand through sensors and settings in homes and apartments. Behavior analysts can implement reinforcement to increase the likelihood of installing such devices and use self-management strategies such as self-monitoring so that consumers can identify the monetary and GHG emissions impact of their current appliances versus the energy-saving ones. In addition, smart water monitors can detect and report leaks and water usage by connecting to one’s water meter. For instance, behavior analysts can promote the adoption of smart home monitors through feedback or reinforcement and provide specific and immediate information to the concerned consumer.

A rise in GHG is associated with a temperature rise; locations worldwide are experiencing severe drought conditions (Fielding et al., 2012; National Integrated Drought Information System; NIDIS, n.d.; Vörösmarty et al., 2000). For example, California is in a “megadrought” (Williams et al., 2022), and as of July 2021, 50 of the 58 counties remain in emergency drought conditions as declared by the governor. This has prompted state officials to draft legislation to establish total water budgets of 55 gal per person per day (gal/person/day) by 2022 and 50 gal/person/day by 2030 (Weiser, 2018). In addition, researchers have examined various interventions to save water at the household level. This includes education campaigns (Appelboom, 2009; Chan, 2021; Heiman, 2002; Hodges et al., 2021; Syme et al., 2000), manipulating pay structures (Agras et al., 1980; Lu et al., 2019; Ratnasiri et al., 2018; Rosenberg, 2009), integrating water-efficient appliances (Bennear et al., 2013; Perez-Urdiales & Baerenklau, 2019), and feedback (Brent et al., 2015; Cominnola et al., 2021; Geller et al., 1983; Otaki et al., 2020). These studies have demonstrated some impact on reducing water consumption. Still, there are many limitations, including the participant response effort, relying on self-report, lack of data transparency, and study duration. Above all, these studies lack behavioral principles for long-term change.

In the last 40 years, behavior analytic research on water conservation has been less researched. For example, Gelino et al. (2021) identified only one study focused on water conservation (Agras et al., 1980). In 1983, Geller et al. attempted to address water conservation utilizing the same interventions (e.g., feedback, installation of water-saving fixtures, and information) used in electricity-saving studies and had limited success. Research has also used antecedent strategies (e.g., information
campaigns that begin at the onset of drought or installation of high-efficiency appliances or fixtures; Appelboom, 2009; Bennear et al., 2013; Chan, 2021; Heiman, 2002; Hodges et al., 2021; Perez-Urdiales & Baerenklau, 2019; Syme et al., 2000) or punishment in the form of fines or increasing pay structures (Agras et al., 1980; Lu et al., 2019; Ratnasiri et al., 2018; Rosenberg, 2009). These studies, however, are not strictly behavior analytic. The field of study is currently wide open as there has not been sufficient intervention to continue water conservation long term. Behavior analysts can start by selecting interventions for study and applying behavior analytic principles.

Behavior analysts can work with consumers and local governments in various ways to promote the management of resources, such as adopting high- and low-tech replacements to support energy conservation. For example, many energy and water use rebates and incentives are available through companies and local and state governments to incentivize purchases. Retrofitting homes with high-efficiency appliances has shown to be an effective intervention for immediate savings (e.g., high-efficiency toilets, washing machines, etc.; Bennear et al., 2013; Pérez-Urdiales & Baerenklau, 2019). In addition, rooftop small-scale solar systems can provide household energy. Wide-spread adoption could reduce GHG emissions by 155% of 2005’s emissions by 2050 (Solar Energy Technologies Office, n.d.). Behavior analysts can work with local governments to effectively disseminate existing incentives (e.g., Rosenfeld, 2021) or work with electric companies and consumers about renting their roofs for solar power or selling it back to the grid (e.g., Pickerel, 2020).

Transportation Sector Transportation is the leading cause of GHG in the United States. Between 1990 and 2019, GHG emissions in the transportation sector increased more than in any other sector (Environmental Protection Agency, n.d.-a). There are many options for alternative transportation other than single-occupancy vehicles. If one is to utilize a gas-powered or hybrid vehicle, eco-driving can also maximize fuel efficiency or ridesharing. There is also an opportunity to utilize many low emissions technologies, such as increasing use of public transportation and promoting other cost-effective transportation modalities, such as electric vehicles and bicycles.

Eco-driving encompasses a class of behaviors to maximize energy (i.e., fuel) efficiency. There can be static interventions, such as the “Golden Rules,” or dynamic interventions, such as the in-vehicle monitors that provide real-time feedback, including miles per gallon used (MPG; Tu & Xu, 2022). The Golden Rules include: (1) consider excess use (e.g., turn off electrical equipment if not needed, minimize air conditioning, avoid aerodynamic drag, and avoid carrying excess weight), (2) maintain a steady speed (e.g., braking and accelerating smoothly), (3) maintain the vehicle (e.g., tire pressure, oil changes, etc.), and (4) anticipate the flow of traffic (Ecodrive.org, 2022; Tu & Xu, 2022). Newsome et al. (2021) showed that fuel efficiency increased in proportion to the rate drivers created novel verbal rules about the digital numeric feedback display in their vehicles. They found that all participants showed improvements in fuel efficiency, but those who generated fewer novel rules also demonstrated less improvement in fuel efficiency. In addition, behavior analysts can prompt self-monitoring and feedback. Many newer vehicles will provide...
feedback on fuel efficiency. However, behavior analysts can also use low-tech measures, such as monitoring fuel receipts and miles driven and then comparing changes in MPG or duration between refills if mileage remains relatively constant.

Ridesharing apps are already popular, and have been used by over a third of the United States population (Statista, 2022a); they are also associated with reductions in GHG (Wang, Liu, et al., 2022b). The Covid-19 pandemic resulted in passenger restrictions (Occupational Safety and Health Administration, 2021). However, there was a decrease in transportation use and GHG emissions during this period (Rasmussen, 2021). As restrictions around the world ease and GHG emissions increase, behavior analysts should prompt ridesharing and carpooling apps that match drivers and passengers headed in the same direction. This reduces the likelihood that the ridesharing app functions as a taxi service. Instead, the carpooling app, like GoCarma® carpooling, connects neighbors and provides a maintenance payment rather than a profit-based payment (Carson, 2014). Promoting and utilizing similar carpooling apps will reduce GHG congestion in urban areas.

Similar to ridesharing, mass transit (i.e., bus, metro, tram, and commuter rail) reduces travel in personal vehicles. However, many rely heavily on vehicles and use public transportation at relatively low rates (Richter, 2022). The lack of access to public transit and reliance on vehicles for long distances creates inequity across populations regarding access to quality employment, recreation, and educational opportunity. The Urban Institute provides recommendations for guiding federal policy on planning public transit (Freemark & Tregoning, 2022) and may serve as a good resource.

Promoting the use of electric bicycles or scooters (e-bike and e-scooter, respectively) or shared transportation can significantly reduce GHG emissions in urban settings. McQueen et al. (2020) modeled data from a North American study on e-bike use and projected that 15% regional adoption in Portland, OR would reduce CO₂ emissions by 1000 metric tons per day, primarily from transitioning away from car use. Bike sharing systems can use smart bikes that track GPS or utilize a smart dock, and riders return the bikes to a specific location. The smart dock produces more GHG emissions in production, but it may be preferable for higher-density cities, particularly in bike-friendly areas (Bonilla-Alicea et al., 2020). This would have significant impacts if adopted across major cities and suburbs of those major cities across the US. Behavior analysts can advocate for e-bike and e-scooter sharing programs, promote city planning that supports dedicated traffic lanes, and collaborate with companies to incentivize use to shape behaviors such as biking to destinations instead of using cars in cities.

Behavior analysis can also work with electric vehicle (EV) manufacturers’ and states’ incentives and consumers to promote purchasing battery and plug-in vehicles instead of conventional gas-powered vehicles. Research also shows that EVs are easier to maintain than conventional vehicles, which would be an added financial reward for adopters of these behaviors (Williamson et al., 2018). The Biden–Harris Administration is seeking to shift to 50% EV sales by 2030 and has invested in a wide network of EV charging stations (The White House, 2021). Likewise, California’s Adoption of EVs will dramatically decrease GHG as 60% of the transportation-related emissions comes from the transportation section (Tonachel, 2015). Further,
behavior analysts can reference Executive Order N-79-20 in California as a model which discontinues the sale of gas-powered vehicles in the state by 2035 (Newsom, 2020). The enforcement of this legislation may increase the sales of electric and alternative-powered vehicles while decreasing gas-powered vehicle sales before 2035. Finally, behavior analysts need to advocate and apply for grant and foundation funding. Specifically, we need to recognize that effective single-subject research can serve as pilot research for government-funded grants.

**Policy** Across all sectors, behavior analysts can also advocate for public policy and educate consumers to do the same. We propose that behavior analysts can organize using existing state and international organizations, including special interest groups (SIGS) focused on these areas (e.g., Behaviorists for Social Responsibility (BFSR) and Behavior Analysis for Sustainable Societies (BASS)). Macura et al. (2022) may be a good reference; they reviewed public policy interventions on food sustainability and included only studies that directly or indirectly measured environmental outcomes. However, they did not include behavior analytic interventions. This is not surprising given that Biglan et al. (2020) reported a lack of experimental data on community interventions for reducing GHG emissions. Subsequent research also showed a lack of funding for behavior analytic interventions for reducing GHG emissions (Bonner et al., 2021). In addition, behavior analysts can look to the successes and strategies for the public policy mandating ABA as medically necessary treatment (Association of Professional Behavior Analysts, n.d.). However, there is an urgent need to influence people’s behaviors on a large-scale population basis, specifically by influencing the consumption patterns of individuals and communities, which can, in part, affect the actions of communities, businesses, and governments. As such, it is recommended that behavior analysts advocate by providing model legislation.

Legislators may benefit from model bills when the legislators lack the knowledge, resources, or time to craft legislation (e.g., Hertel-Fernandez, 2014). In addition, because policy design and framing can influence public support (Stokes & Warshaw, 2017), behavior analysts can also look to other municipalities, states, and countries to provide approved legislation to serve as a draft. For example, senate-approved California legislation limits methane emissions (see Senate Bill 1383; California Legislative Information, 2016). Likewise, Switzerland banned landfilling compostable waste in 2000, requiring citizens to dispose of organic matter by composting (Wäger, 2007). Behavior analysts can look toward successful legislation and modify it for their state’s needs.

In addition, behavior analysts should be aware of their representatives’ stances on climate change. Depending on their geographical location within the United States, they may affect more change. Politicians that have published website stances on climate change may be more amenable to supporting pro-environmental legislation (e.g., Rublee et al., 2022). However, many states least prepared but most vulnerable to climate change (Trust for America’s Health, n.d.) may be less likely to support pro-environmental legislation. In these cases, it might be helpful to draft legislation that highlights social, environmental, and economic policies to increase support (Bergquist et al., 2020). Behavior analysts in these areas may also need to establish grassroots support to persuade their elected officials. The Indivisible Team provides
a structure for organizing from the grassroots to local advocacy (Levin et al., 2016). Advocating for public policies in the United States is an important step in intervening on a broader level, and if legislated, it would impact wide-scale change across all levels of the Six Americas.

**What Can Behavior Analysts do for the Cautious and Disengaged?**

The Cautious and Disengaged comprise 23% of the population and are not concerned about climate change. In addition, these individuals had questions in all four categories, evidence, causes, and consequences of climate change, as well as what actions to take. These groups would benefit from educational interventions and are not likely to take action to mitigate climate change effects. Thus, we suggest testing the merit of the SASSY! as an assessment tool.

The SASSY! asks questions that can guide educational interventions. As previously stated, the questions are about (1) the importance of climate change to one personally, (2) how worried one is about climate change, (3) how much one believes one will be harmed personally by climate change, and (4) the harm of climate change to future environments. Behavior analysts can administer the SASSY! and record the responses to each of the four questions and educate in targeted areas. Behavior analysts can administer the SASSY! on multiple occasions to see if responses change resulting from contacting educational materials. For example, if consumers do not move toward Concerned or Alarmed, this may suggest that the SASSY!, at least within this instance, does not prove useful.

We recommend educating on the climate crisis and disseminating practical behavior analytic technology to increase pro-environmental action. Getting people to change their consumption can be daunting. It requires massive information efforts and public speaking skills. According to Dilling and Moser (2011), climate change science is experiencing a lackluster performance for four main reasons: lack of information, motivation by fear, lack of diversity in framing issues to diverse audiences, and utilization of mass media. Much of the current climate change message is anxiety-provoking or what climate change communicators call “apocalypse fatigue” (Nordhaus & Shellenberger, 2009). Behavior analysis has much to offer climate change science (Wille & Lange, 2022). Behavior analysis can offer a guiding light here, and dissemination will be a critical component. Persuasive narratives might be necessary to communicate the urgency and solutions for climate change (Bloomfield & Manktelow, 2021; Gustafson et al., 2020; Jones & Peterson, 2017). Behavior analysts have also stressed the importance of public speaking and communicating effectively to your audience (e.g., Bailey & Burch, 2010; Detrich, 2018; Friman, 2014; Heinicke et al., 2022). Behavior analysts would benefit from honing the skill of crafting a compelling accurate narrative and communicating it effectively.
What Can Behavior Analysts do for the Doubtful and Dismissive?

Those in the Dismissive group and the Doubtful group comprise the smallest portion at 19% of the population. These individuals are more likely to identify as Republican or conservative (Leiserowitz et al., 2021). In addition, those in the Dismissive group may actively work against initiatives to mitigate the climate crisis, and those in the Doubtful group are more prone to listen to the evidence contrary to climate change. However, connecting the desired behavior to individuals’ values may prove beneficial.

The outcomes of mitigation strategies can be the same even if the reasons (i.e., values) to engage in these strategies differ. Behavior analysts can provide brief Acceptance and Commitment Therapy-based exercises to identify the values of individuals within this group. Many values-identifying exercises can be found through the Association for Contextual Behavior Sciences (contextualscience.org). Further, Wolsko et al. (2016) evaluated the effects of specific word choice on intentions, attitudes, and donations to environmental organizations for liberals and conservatives. Liberals were supportive regardless of the wording choice. However, conservatives were more likely to support environmental organizations when they emphasized duty, protection, American pride, patriotism, civic duty, respect, and defense. In addition, individuals may unintentionally engage in energy-efficient behavior due to adopting more cost-efficient alternatives. Therefore, behavior analysts should educate about rebates and incentives available to reduce costs and mediate climate change’s effects. Further, a plant-rich diet or exercise using alternative transportation, such as walking or biking nearby, can be advantageous for a healthier lifestyle and associated with lower GHG emissions. Unfortunately, associating health with climate change is generally counterproductive for this group (Maibach et al., 2010). Therefore, when working toward climate change action with individuals, it is important to identify and emphasize social and economic benefits rather than environmental benefits.

Conclusion

Individuals faced with the enormous problem of climate change may feel hopeless about affecting change on a scale that matters (Soutar & Wand, 2022). These feelings can take someone from anxiety to action (Bright & Eames, 2022). However, no matter how minimal, individual behavior can make a decisive difference when taken up by millions of people, as evidenced by mask-wearing, distancing, and hand hygiene during the Covid-19 pandemic (Di Ciaula et al., 2021). No one has a monopoly on climate change. We all contribute to and are responsible for combatting it. Applied behavior analysts offer a unique set of skills in effectively assessing and intervening in human behavior.

Toward this goal, behavior analysis can employ assessment tools to identify successful mitigation and adaptation factors. In addition to the behavior analysts’
current assessment tools, we believe that behavior analysts can use the 4-item Six Americas assessment, SASSY!, to rapidly categorize individuals and match them to effective behavior analytic interventions for their category. Further, behavior analysts can evaluate if the SASSY! can serve as a useful assessment tool by evaluating if educational interventions are effective in moving an individual toward a category associated with an action (e.g., from Cautious to Concerned) or to assess if the categorization is useful. (e.g., Is the Alarmed group more likely to act?) Then, informed by assessment, behavior analysts can educate, motivate, and influence individuals toward successful adaptation and mitigation pathways built on the science of behavior toward climate change interventions (Heward & Chance, 2010; Williamson et al., 2018).

Commonplace behavior analytic applications could have profound outcomes when collaboration with other fields and stakeholders is also embraced. Previous research has well-established dependent measures and interventions across the food, energy, and transportation sectors. We offered directions and suggestions for taking actions where effective interventions have not been applied. Behavior analysts are called on to expand the existing sustainability research, collaborate with others working toward this important cause, and take action today.

Data availability Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Declarations

Conflict of interest We have no known conflict of interest to disclose.

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