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It's Still Hot in Here: Exploring the Relationship Between Incentivization and Climate Related Behaviors to Combat Climate Change

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IT'S STILL HOT IN HERE: EXPLORING THE RELATIONSHIP BETWEEN INCENTIVIZATION AND CLIMATE RELATED BEHAVIORS TO COMBAT CLIMATE CHANGE

A Master's Thesis

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In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Applied Behavior Analysis

By

Meredith T. Matthews

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ABSTRACT

Consumer behavior continues to play a centralized role in the anthropogenic (i.e., human) factors causing exponentiated rates of climate change at a global scale. The present study utilized a mixed-method research design which combined components from both quantitative and qualitative research. The purpose of the mixed-methods study was to examine the extent to which self-monitoring and incentivization through extra credit in a graduate psychology course would impact participants pro or anti-climate behaviors using two commercially available applications. In the primary study, eight participants selected from a graduate psychology course at Missouri State University completed a combined intervention including self-monitoring of climate related behavior using two commercially available applications. Following the two weeklong baseline phase, extra credit was provided contingent upon improved performance in a changing criterion design across participants. After the intervention phase, a follow-up qualitative interview was completed with all eight participants, to obtain the perspectives of the participants about different components of the research study. A three-tiered thematic analysis was conducted. Three major themes emerged throughout the analysis: (1) barrier to reducing emissions, (2) behavioral influence, and (3) influence of values. Results provide implications for future research, and limitations as well as potential avenues for future research are discussed.

KEYWORDS: climate change, consumer behavior, incentivization, eco-feedback, thematic analysis

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INTRODUCTION

Feedback is any information an individual receives regarding a specific aspect of their behavior following the completion of that behavior (Cooper et al., 2019). An example of feedback might be "You're right, 2+2 does equal 4." While the majority of feedback is provided verbally, feedback can also be provided through the use of technology, for example through persuasive technology. Persuasive technology is an interactive system designed to motivate and increase the frequency of individuals desirable and beneficial behaviors while working in tandem to avoid the undesirable or harmful behaviors (Orji & Moffatt, 2016). One of persuasive technologies goals, is to combine technological innovation and the psychological contributions as a means of tackling environmental issues and climate change more broadly (Midden & Ham, 2018). Eco-feedback technology is one derived from persuasive technology with the overall goal focused on decreasing environmental impact (Orji & Moffatt, 2016).

Eco-feedback technology provides its consumers with climate related usage information on both a group and individual level in order to promote more awareness of carbon emissions (Froehlich et al., 2010). Eco-feedback technology is based on the working hypothesis that individuals are vastly unaware of the effects their everyday actions impact the environment, with the idea that technology can be used to bridge this gap in awareness. The use of eco-feedback to target the impact of human behavior on the environment dates back more than 50 years to the study of environmental psychology and has been used to track and provide feedback on a variety of different climate related behaviors for example tracking home electricity usage, water usage, as well as recycling and waste disposal (Froehlich et al., 2010). However, unfortunately due to

the lack of interest in these technologies upon their creation, some of the original pieces of technology are no longer being produced.

The field of human computer interaction is one that is dedicated toward creating programs and applications to encourage pro-environmental behaviors (Froehlich et al., 2010). Unfortunately, there is often a lack of understanding or communication between the fields of human computer interaction and that of environmental psychology when designing these programs or the framework with which they operate from. This lack of mutual understanding is commonly referred to as the "environmental literacy gap" which can be defined as an individual's inability to understand how individual behaviors affect both the local and global environment (Levitt, 2021). One solution to this literacy gap is the incentivization of pro-climate behaviors, however there is currently no literature focusing on such a procedure.

Incentives are defined as anything that incites or has a tendency to motivate or encourage someone to do something (Merriam-Webster. (n.d.). Within the field of behavior analysis, incentives have been used in a variety of ways and one such example is can be seen through the demand curve. The demand curve is the idea that when something gets more expensive, people buy less of it and when it gets less expensive, people buy more of it. Similarly, the rational choice models assume that human behavior is regulated by a systematic process of evaluating outcomes and that individual decision making is done in such a way that aligns with personal goals (Ganti et al., 2022).

However, the rational choice theory is not a one size fits all approach and modifies its different components to fit the situation at hand however all rational choice theories utilize the same three components (Liebe & Preisendörfer, 2010). First, actors serve as the foundation for all explanations. Second actors have at least two different courses of action from which to

choose. Third, the theory includes a decision-based rule that specifies which action the actor will take (Liebe & Preisendörfer, 2010). Stated in another way, people act in ways that maximize reward and minimize cost. However, as humanity has evolved, individuals have increasingly used what are commonly referred to as heuristics, or the shortcuts people use to arrive at decisions (Rachlin, 2003). When presented with a choice in the moment, people lack the necessary time to consider the advantages and disadvantages of both options in order to choose the best course of action. Therefore, the use of heuristics has emerged as the ideal method for solving a number of real-world issues that people in today's society encounter. One of these adaptive heuristics is recognition, which enables a person to respond or express a preference in light of prior knowledge and experiences (Rachlin, 2003).

Even with adequate knowledge of how to protect the environment and a stated intention to do so, many individuals still do not act in a consistent manner toward the environment, environmental protection, or pro-climate behaviors in general (Amel et al., 2017). In addition, there is a significant gap between people's self-reported knowledge, beliefs, thoughts, and intentions and their observable behavior. The effects of anthropogenic, or human caused, emissions on global ecosystems are approaching a climate point of no return (Masson-Delmotte, 2021). It is becoming increasingly clear that any solution must be based on population-wide behavioral changes. However, for such changes to occur, a sizable proportion of the population must be willing to support them.

LITERATURE REVIEW

The Current Status of the Climate Change Crisis

Since 1880, the Earth's surface temperature has risen gradually by about 0.08°C (or 0.14°F) each decade, however, the rate of warming since 1981 has more doubled since then, with each decade warming by about 0.18°C (or 0.32°F) (National Centers for Environmental Information (NCEI; 2022). Taken together, the Earth is now about 1.1°C (or 2°F) warmer than it was during the 1800s (Masson-Delmotte, 2021) and unless new technologies are developed or global warming begins to slow, the global surface temperature is currently projected continue to increase by 2.7°C (or 4.8°F) before the end of the century.

Thermal inertia is the term used to describe the degree of slowness with which something has a change in internal temperature that reaches that of its external environment (Ng et al., 2011), which for the purposes of this review is the Earth's surface temperature. The Earth is comprised of countless different materials, each with varying thermal inertias which in turn require varying lengths of time in order to change temperatures (Environmental Protection Agency, 2021). A good example of this can be seen through the two main components of a beach: the sand and the water. The sand on a beach has a low thermal inertia meaning that it is less resistant to change and takes a small amount of time to warm up or cool down, whereas the water has a high thermal inertia meaning that it is resistant to changes in temperature and takes a long time to warm up or cool down (Ng et al., 2011). So, not only does global warming not occur at the same rate across the entire planet, but due to the delay in cooling even if greenhouse gases do not surpass their current levels, temperatures and sea levels will continue to rise for the next century or more due to a time lag in the oceans' response to atmospheric temperatures.

Furthermore, the increase in water temperature causes the molecules to expand resulting in an additional rise in overall sea level.

Temperatures can vary significantly locally and over short periods of time due to recurring and predictable, patterns such as night and day or summer and winter, as well as wind and precipitation patterns which are more difficult-to-predict (Environmental Protection Agency, 2021). While local weather may vary significantly from week to week or month to month, the global surface temperature is not as easily changed. The global surface temperature is determined primarily by how much energy the Earth receives from the Sun and how much it radiates back into the atmosphere, and more generally speaking, space as a whole. While the amount of energy emitted by the Sun varies very little year to year, the energy emitted by the Earth on the other hand is closely related to the chemical composition of the atmosphere, particularly the amount of greenhouse gases that have been trapped within the Earth's atmosphere, thus making the energy expelled from Earth and into the atmosphere unstable.

The NASA Goddard Institute for Space Studies (Schmunk, 2022) was established in 1961 and is a leading center for climate change, due to the institute's past research focusing on the changes in the Earth's atmosphere and surface temperature. The Goddard Institute was largely created in order to conduct research on the origin and evolution of the Earth, Moon, and other planets as well as their atmospheres, the chemical and physical makeup of the planetary bodies, and the composition and evolution of stars (Schmunk, 2022). As a result of the institutes early research and data collection on the Earth and other planet's atmospheric and climate related changes, the Goddard Institute has developed an approach to make predictions of the atmospheric and climate related changes through the analysis of comprehensive datasets.

However, before discussing what could happen regarding the Earth's climate, it is first relevant to discuss what has already happened thus far.

According to the latest Intergovernmental Panel on Climate Change (IPCC; Masson-Delmotte, 2021) report, many of the changes already taking place throughout the Earth's climate are considered to be irreversible and have not been observed in thousands, if not hundreds of thousands of years. The IPCC asserts that the impact of climate change on particular regions will vary over time and depending on how well various societal and environmental systems are able to adapt or mitigate the effects of change (2021). Across the United States alone, the average surface temperature has risen continuously across the 48 states since 1901 (Environmental Protection Agency, 2021). More alarmingly, temperatures in the North, West, and within Alaska have experienced the most warming overall. This can also be seen when looking at global surface temperatures, with eight of the top ten warmest years occurring after the year 1998. The year 2016 is considered to be the warmest year recorded, with 2020 being the second warmest year and the entire decade from 2011-2020 ranking at the warmest decade on record (National Centers for Environmental Information; NCEI, 2022). This is incredibly significant, especially considering the COVID-19 pandemic and its necessitation for stay-at-home orders, thus temporarily reducing overall carbon dioxide (CO_2) emissions worldwide.

As mentioned previously, the Earth's surface temperature, or global warming for that matter, does not experience increases in temperature or change at the same rate across the planet. Instead, the Earth warms at a varying rate across different topographies, ecosystems, as well as during the changes in seasons. Each year, the Environmental Protection Agency (2021) measures the length of the current season and discovered that the growing season has increased by about one day each decade since the year 1895, whereas in the west, the growing season has increased

by roughly 2.2 days each decade. While a few days may seem insignificant, the length of the season widely affects the crops that are able to grow and while a longer growing season may result in a more diversified crop for farmers, it can also result in a reduced number of crops that are able to grow within a specific environment in addition to encouraging invasive species both for crops as well as animals. Furthermore, an extended growing season could disrupt the structure and function of a particular region's ecosystem, with potential effects on the types of animals that live there as well as the ecosystems themselves.

The environment as well as the wildlife are strongly dependent upon external changes in temperature, considering that changes in external temperature disrupt the natural process that plants and animals engage in throughout their lifetime. This is especially true when these changes happen faster than the species itself is able to adapt (plants as well as wildlife). Rising temperatures along with deforestation and increasing rates of industrialization leads to a shift in ecosystems which in turn can lead to uninhabitable environments thus forcing animals outside of their habitats (IFAW, 2022). Natural disasters threaten the wildlife with which reside within their usual environment, with a recent example of this being the Australian bush fires that ranged from June of 2019 to February 2020 (Vernick, 2020). In fact, the year 2020 bore witness to five of California's ten largest wildfires on record, not to mention the state also set a new record for acres burned. A summary of all the fires in 2020 reported over an estimated 4.3 million acres had been burned by the more than 8,600 wildfires (California Department of Forestry and Fire Protection; CAL FIRE, 2020). Throughout all of the fires, 33 people died and roughly 11,100 structures were damaged or completely destroyed (CAL FIRE, 2020). These changes in wildlife and biodiversity in general are staggering, however the issue of climate change will also have a wide-ranging effect on the humans living within the ecosystem as well.

Despite the growing body of research, as well as the previous research completed by the NASA Goddard Institute, it is impossible to determine exactly what the long-term effects of the current state of the Earth's climate will be. Further, extreme weather patterns are considered to be particularly devastating for people who are exposed to the outside temperature, for example through their job such as construction workers, landscapers, farmers, or street vendors as well as individuals of low socioeconomic status or the homeless population. Furthermore, increasing temperatures, the risk for more intense heat waves increases exponentially, and this is significant for all walks of life.

Incentive-Based Interventions, Eco-Feedback, and Related Applications

The three-term contingency is oftentimes referred to as the ABCs of behavior and it describes the antecedent conditions immediately preceding a behavior, the behavior itself, and the how the consequence provided will affect the future occurrence of the behavior (Meredith et al., 2014). This contingency is the cornerstone of behavior analysis. Similar to the three-term contingency, individual pro-climate behavior is also influenced by an individual's attitudes, beliefs, motivation as well as their personal values (Solomon & Lowrey, 2020). As a result, whenever an incentive-based intervention is being created, healthcare professionals must at the very least take into account the three components of a contingency: antecedents (A), behavior (B), and consequences (C). A prompts B, and B is altered by C (Meredith et al., 2014).

When approaching consumer behavior, the rational economic choice models assume that when provided with a choice between two products, and all else is held constant, consumers will select the lower cost product assuming the quality is the same. This is idea is known as the matching law which states that consumer behavior is performed in a ratio that matches the ratio

of available reinforcement provided for the respective behaviors (Herrnstein, 1961; Chance 2003). Examining the relative rates of reinforcement associated with each option can help behavior analysts understand choice (i.e., relative preference) and accurately predict it. Some trivial examples of this theory include favoring a pair of jeans over khakis, choosing one topping of pizza over another, and exhibiting environmentally friendly or environmentally harmful behavior (examples adapted from Herrnstein, 1961).

The matching law can also be applied to the value of various reinforcers as well, and in turn sources of reinforcement will result in higher rates of overall behavior (Herrnstein, 1961). Take for example the various extrinsic and intrinsic motivators interacting between taking the transit system to work in place of driving carpooling to work (Pugno & Sarracino, 2021). If the current state of the environment continues in the direction it is currently projected to without making any significant changes in climate related policy, the residual effects will be irreversible. This fact is a strong intrinsic motivator for pro-climate behavior; however, it is not necessarily more motivating than arriving to work on time (Pugno & Sarracino, 2021). As a result of this, individuals will likely continue to drive their vehicles to work each day. Consumers are constantly being faced with values decisions such as these, and if a science of human behavior is going to be a part of the solution, then future research is needed in this area.

Schoeppe and others (2016) conducted a literature review from the year 2006 through 2016 seeing as the use of smartphones did not occur before 2006, and through the use of a variety of different terms the researchers compiled 27 articles reporting app based behavioral improvements. Throughout their findings, the authors compiled a list of various characteristics used in efficacious interventions. When using a mixed-methods strategy, application therapies in general have shown significant improvements in the behavioral and health outcomes of its users

(Fukuoka et al., 2010). The use of goal setting, self-monitoring, and performance feedback in the application design has also demonstrated significant improvements in the behavioral and health outcomes within numerous treatments (Allman-Farinelli et al., 2016; King et al., 2013; Walsh et al., 2016). Other effective behavior modification strategies that have been incorporated into certain successful interventions include friendly team challenges (Garde et al., 2015, King et al., 2013), reinforcement (Allman-Farinelli et al., 2016; King et al., 2013), peer interaction (Allman-Farinelli et al., 2016; Garde et al., 2015), gamification, awards, and motivational messages (Fukuoka et al., 2010; Elbert et al., 2016). The current literature lacks the necessary data to pinpoint the behavior modification strategies that contribute to intervention efficacy. In addition, there was no distinction between the behavior modification strategies utilized in programs for adults and those for children. Considerable research has demonstrated app usage data that indicate significant changes in behavioral and health outcomes (ex. Partridge et al., 2015; Wang et al., 2015). Increased application usage resulted in considerable increases in physical activity as well as healthy eating (Wang et al., 2015). While the current literature surrounding the use of behavior modifying applications is fairly promising, particularly surrounding the usage of a mixed-methods research designs, additional research is always needed.

Contingency Management

Behavior analysis encompasses the application of learning principles (such as the principles of operant conditioning) in the treatment of behavioral issues as well as the study of the links between behavior and environment that affect learning.

Contingency management is an effective behavioral treatment used to treat a variety of aberrant behavior such as substance use (Dutra et al., 2008) and originated in the early 1970's

through the use of operant conditioning within animals (Stitzer & Petry, 2006). The goal of contingency management in general is to analyze an individual's present environment and modify the contingencies surrounding an individual's aberrant behaviors using core behavioral principles, such as reinforcement, punishment, and extinction (Wright, 2015). There have been hundreds of experimental and randomized controlled studies that have been conducted to demonstrate the efficacy and adaptability of contingency management interventions (Dallery et al., 2019). In order to modify contingencies and change the rate of the target behavior, a contingency management intervention may be developed following a thorough functional analysis of the controlling contingencies, rearranging the functional analysis of those controlling contingencies, rearranging the functional environment, and careful outcome monitoring (Wright, 2015).

Historically, contingency management has been delivered face-to-face however one significant barrier to contingency management treatment is the patient's ability to access the treatment due to physical proximity (Dallery et al., 2019). However, because of the advances in technology, specifically in mobile technology, contingency management can now be delivered through the use of technology. A systematic review was conducted by Kurti and colleagues (2016) to outline the literature surrounding remote incentive-based interventions regarding health-related behavioral change. Studies included within the review were required to utilize financial incentives for health-related behavioral change, be published in a peer-reviewed journal, as well as incorporate a research design that compared the intervention to another condition. The included studies were required to use technology to monitor the target behavior and/or deliver incentives contingent on the completion of those the target goal (Kurti et al., 2016).

A crucial element of a successful incentive-based intervention is the contingent relationship between behavior and its results. Unfortunately, consequences (including incentives) do not offer the same treatment outcomes as those that are available unconditionally or without achieving the desired behavior change (Meredith et al., 2014*).* In addition, a number of other variables can play a significant role in whether a consequence will influence behavior, for example individual characteristics (e.g., an individual's degree of motivation), however regardless of whether a contingency is arranged by a treatment provider or occurs naturally, each of these variables plays an important role in determining whether a consequence will influence behavior.

Qualitative Research and Null Findings

Within qualitative research interviews, there are three primary types of interview format: structured, unstructured, and semi-structured (Ritchie & Lewis, 2003). Structured interviews are verbally administered questionnaires which deviate very little from the predetermined questions and provide no follow up or clarifying questions (Legard et al., 2003). Unstructured interviews on the other hand do not reflect any preconceived ideas and enter into the interview with very little organization (Ritchie & Lewis, 2003).

In 2006, Braun and Clark outlined the theory, application, and evaluation of the qualitative thematic analysis by emphasizing the flexibility of the thematic analysis as well as providing a protocol for experimenters to complete thematic analyses in a more scientifically justified manner. This was done through the development of a stepwise model broken into six phases, which are as follows: becoming familiar with the data, generating the initial codes,

searching for themes, reviewing the themes, defining and naming the themes, and finally producing the report (Braun & Clarke, 2006).

Step 1: *Becoming familiar with the data*. This includes transcribing data as well as reading and noting any initial thoughts or ideas (Braun & Clarke, 2006). Step 2: *Generating the initial codes*. Researchers are expected to take notes on potential data of interest and begin the coding process. According to Boyatzis (1998) a code is "the most basic segment or element of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (p. 63). Step 3. *Searching for themes*. After the codes are collated, researchers can begin to analyze them into larger representative themes (Braun & Clarke, 2006). This idea can be understood through an analogy comparing the qualitative thematic analysis to a house, stating that the bricks and tile of the home are the individual codes whereas the themes are the walls and roof of the home (Braun & Clarke, 2012).

Step 4. *Reviewing themes*. Step four is unique in that it is the only step of the thematic analysis that has two parts. In the first part of this step, it is the researcher's job to review all the relevant codes under the various themes and ensure each have adequate support. It is also in this stage of the analysis that any codes be removed or resorted, as well as modifying the relevant themes to best reflect the data listed throughout the analysis. During the second part of this step, researchers decide whether the individual themes fit within the thematic analysis to ensure all of the data are represented within each of the different themes (Braun & Clarke, 2006). Step 5. *Defining and renaming themes*. Following the refining process of the thematic map, researchers are able to name and define the various themes included within the thematic analysis, while ensuring that both descriptors and titles are thorough and concise (Braun & Clarke, 2006). The

way the researchers completed this, was through what is called affinity diagramming (Harboe & Huang, 2015).

It is also important for researchers to extract data (e.g., narrative quotes from participants) that best represent the themes and the context surrounding their importance (Braun & Clarke, 2012). Step 6. *Producing the report/manuscript*. The final step is the actual write up of the thematic analysis as well as a description of the findings of said analysis that includes both the description of the codes and themes as well as a clear and logical account of how the researcher was able to analyze the data via the narrative quotes found throughout analysis (Braun & Clarke, 2006; 2012).

In scientific research the potential for a particular stimulus to have an effect on the outcome within a population is commonly referred to as the alternative hypothesis. Conversely when a particular stimulus does not exercise an effect on the target population it is commonly referred to as the null hypothesis. The most common statistical procedure for inferring population effects is Null Hypothesis Significance Testing (NHST). Despite its numerous well-documented flaws, NHST remains the dominant method for drawing conclusions from data, despite these justifications being inadequately examined. Furthermore, most scientists (particularly psychologists, biomedical scientists, social scientists, cognitive scientists, and neuroscientists) are still nearly entirely educated in NHST, and the method is nearly entirely dominant in scientific papers (Chavalarias et al., 1990-2015).

Stunt and colleagues (2021) used individual and group interviews among relevant stakeholders in the scientific system (junior and senior researchers, statistics lecturers, editors of scientific journals, and program leaders of funding agencies) to investigate the perceived barriers, contributors, and potential solutions regarding the use of NHST and alternative

statistical procedures (Stunt et al., 2021). Results show that many researchers report feeling reliant on others when reporting scientific results, and they frequently wait for others to take action and undertake the necessary initiatives. This might explain why NHST is still the standard and is used by almost all quantitative researchers (Stunt et al., 2021). By shifting away from NHST, behavioral scientists can create a higher bar for actual behavioral change throughout the usage of mixed-methods research designs. The idea of a mixed method research design is one that is often discussed within the combination of quantitative and qualitative research.

Purpose

The purpose of the present study was to evaluate the combined effects of incentivization and self-monitoring on pro and anti-climate behavior using two commercially available applications. The purpose of the qualitative thematic analysis was to obtain the perspectives of the participants about barrier to reducing emissions, the perceived efficacy of the incentives in the class and embedded in the application, ease of participation in the program, and values associated with climate impact. Extra credit was used as an analogue to financial incentive programs that could be adopted in companies and assisted by the use of the app. The present study applied this same idea to determine the effect that incentivization had on the participants pro-climate behavior.

STUDY 1 METHODS

Participants and Setting

A total of eight participants took part in the research study, and all eight participants identified as Caucasian/white. The ages of the participants ranged from 21 years to 23 years (the average age was 22.13, the standard deviation was 0.99) and all eight participants identified as cisgender females. Participants selected for this study were recruited from a graduate level psychology college course at Missouri State University. Participants received anywhere from 0-3 points of extra credit in their graduate psychology courses contingent on improved performance in a changing-criterion design across participants (3 points maximum per week). The participants received no monetary compensation and could withdraw from the study at any point.

The data for this study was collected throughout the participants daily lives using the LiveGreen application as well as through the use of GPS technology via the participants cellphones. This data was then uploaded to the experimenters at the beginning of the participants regularly scheduled class periods each week. The Environmental Assessment of Responses Toward Habitability (EARTH-beta version; Matthews et al., 2021), a 20-item climate behavioral inventory, was used to estimate engagement in daily consumer behavior related to climate change. The number of total items endorsed as yes on the EARTH-beta version ranged from 2 to 16 out of 20 possible items, the number of total items endorsed as no on the EARTH-beta version ranged from 2 to 16 out of 20 possible items indicating that participants engaged in

variable degrees of pro-climate consumer behavior. A copy of the full survey can be found in Appendix B.

Results of the EARTH-Beta Version are listed in Figures 2 through 11, and participants total items endorsed as a yes ranged from 2 to 16, participants total items endorsed as in no ranged from 4 to 15, and the number of total items endorsed as an I don't know ranged from 0 to 6 out of 20 possible items (see Figures 4-11).

This research was approved by the Institutional Review Board (IRB) on February 28th of 2022. The IRB is listed as IRB-FY2022-394 and the IRB approval page can be found in Appendix A.

Materials

Commercially Available Applications. The LiveGreen app was created to allow consumers to visually understand, reduce, and offset their carbon footprint using the applications three main goals; track and understand carbon emissions, learn how to reduce carbon emissions with daily goals, and offset what carbon emissions consumers cannot reduce. The LiveGreen application led participants through a series of demographic questions, and examples of these questions include the number of people living in their home as well as the cost of their electricity bill each month and their vehicles average miles per gallon. This questionnaire is manually tracked in the LiveGreen application and could be edited at any time to ensure that participants have a better estimate of their carbon footprints.

In order to deliver the questionnaires to the participants, a pre-existing mobile ecological momentary assessment application was used called ExpiWell. The ExpiWell mobile application is a cross platform (iOS and Android) application, where experimenters are provided with the

opportunity to create and distribute unique questionnaires through the online platform. Following a simple download and sign-up process, the participants were able to access the surveys via the application on their mobile devices and be prompted at a pre-scheduled time during their regularly scheduled class to complete the weekly eco-feedback survey.

Task Analysis. Participants were provided with a supplementary task analysis that walked them through the screenshotting and submission process necessary to obtain each individual participant's annual footprint, their carbon footprint as well as other data such as the number of trees they planted, and the number of pounds of CO_2 they had saved thus far (see Figure 1). The task analysis had a total of 33 steps and required the participants to submit 7 total screenshots each week. In addition to the task analysis, every week that the participants submitted their carbon thresholds, a PowerPoint was projected onto the screen in the front of the classroom that provided an example of what each screenshot should look like with the corresponding title listed on the task analysis (see Figure 2). The order of the PowerPoint was arranged to match the order of the task analysis to reduce participant confusion.

LiveGreen Infographic. In addition to the task analysis, participants were given an infographic that outlined the different components of the app (see Figure 2). Consistent with the majority of the LiveGreen app as a whole, the information listed on this infographic was focused on individual behaviors that the participant could engage in to reduce their overall emissions. This was done for two major reasons: to increase the participants current knowledge on the application itself, as well as to increase their buy in for both the LiveGreen application as well as the study as whole.

A unique component of the LiveGreen app was that it used the points earned in the app to plant real trees around the world. These points could be earned through walking, biking, or by

completing the three daily goals. LiveGreen generates three new tips each day that the participants were able to complete, and with 30 points in the app, one tree could be planted in Madagascar, Haiti, or Nepal and with 99 points a tree in an American National Forest can be planted.

EARTH-Beta Version. The EARTH-beta version was developed to provide a behavioral estimate of real-world engagement in pro-climate consumer behavior. Further development of items on the EARTH-beta version are currently underway with larger and more representative samples and the beta-version was used simply as an inventory of behavior for comparison among the participants. Examples items on the EARTH-beta version include: "At least 25% of house lights are energy efficient (e.g., LED smart)", "At least 50% of purchased clothing is responsible, second hand, or is worn more than 30 times", and "All hygiene and/or makeup products are natural (i.e., do not contain unrecognizable chemicals)". The full beta-version of the EARTH-beta version is provided as a supplementary file listed in Appendix B.

The present study was created to use a time-based sampling design in order to gather information regarding the participant's weekly climate related behaviors and was conducted in a graduate psychology classroom. The utilization of a college classroom was done for two major reasons, with the first being the convenient access the experimenters had to this sample. In addition, a college classroom has a unique advantage in that it operates within a closed economy because it provides students with grades, and many components being arbitrary. Extra credit in class was used throughout the study as it is also similar to money, wherein the completion of a job (i.e., studying) leads to the compensation of that job (i.e., a good grade in class).

For the purposes of this study, participants were expected to download two commercially available applications; one application was used to track pro-climate related behavior data

(LiveGreen) and one application was used for data collection (ExpiWell). Table 1 outlines the other climate related applications that were considered for this study. The LiveGreen application was selected over the other applications as it allows consumers to earn points in the application for engaging in pro climate related behaviors such as walking, biking, as well as a myriad of other daily goals that are individualized for each consumer every day.

Dependent Variable and Interobserver Agreement. The dependent variable in this study was the frequency of days participants were able to remain below a predetermined threshold. The frequency of days below the carbon threshold was obtained through data extraction of weekly thresholds as determined by the Annual Footprint graph found in the LiveGreen application.

The present study utilized a changing-criterion design across participants for the quantitative component of the research study. In order to evaluate if there was a relationship between incentivization via extra credit coupled with the points earned in the application itself on participants overall carbon emissions, these variables were analyzed using percent non-overlapping data.

Procedure

Participants were selected from a graduate psychology course, and extra credit was provided contingent on improved performance in a changing-criterion design across participants Participants received the maximum number of points during the baseline phase of the study (3 points each week) and received 0.5 points each day they were able to remain below the predetermined threshold during the training phase of the study. The predetermined thresholds were determined by the lowest threshold within a participant's previous week. For example, if

Participant X submitted their Annual Footprint Graph with the following scores: 17.2, 16.8, 17.6, 17.0, 18.6, 17.3, and 18.1 the threshold that the participant would be required to remain below would be 16.8.

After the recruitment process was complete, participants were required to download the commercially available app titled LiveGreen. Following this, participants were then be asked to complete a demographic questionnaire which asked personal information questions, such as age, identified gender, and identified ethnicity (see Appendix C). Participants then completed a personal lifestyle questionnaire within the LiveGreen app, which included questions about their car, miles driven per week, and their water bill cost per month. Next, the participants completed the EARTH-Beta Version (Matthews et al., 2021)

After the baseline phase, participants completed a weekly questionnaire, which asked them to submit their documentation for the previous week. The submission for each of the components of the study were collected using the ExpiWell application which prompted them to complete the survey at 10:15 AM central standard time, which for the participants included in this study was during their regularly scheduled class.

The participants "Annual Footprint" graphs were uploaded into a data extractor tool; WebPlotDigitizer (Version 4.5; Rohatgi, 2019), which is an opensource semi-automated tool designed to extract the underlying numerical data that has been previously formatted. This was completed by one experimenter (MM) by first aligning the X and Y axes to ensure that the data extracted from each of the participants was as consistent as possible.

Following the data extraction, numerical values were input into Microsoft Excel where they were analyzed to determine each individual participant's lowest footprint for the week, as this numerical value would represent the participant's new threshold to remain below for the

upcoming week. Remember that if Participant X submitted their Annual Footprint Graph with the following scores: 17.2, 16.8, 17.6, 17.0, 18.6, 17.3, and 18.1 the threshold that Participant X would be required to remain below would be 16.8.

After each participants threshold was calculated, the experimenter messaged each of the participants stating their previous thresholds, how many points of extra credit they could receive each week, followed by how many days they were able to remain below their previous threshold as well as how many points of extra-credit they received and what their new threshold for the upcoming week would be.

An example of the statement provided to participants receiving new thresholds is listed below:

> *"Hello! Your previous threshold was 15.2, and 0.5 points of extra credit will be awarded for every day you remain below this threshold. Last week you remained below this threshold for 2 days, which gives you 1 point of extra credit this week. Your new threshold for this week is 15.0. Be sure to check your app frequently to monitor your progress!"*

An example of the statement provided to participants who did not receive new thresholds is listed below:

> *"Hello! Your previous threshold was 9.1 and 0.5 points of extra credit will be awarded for every day you remain below this threshold. Last week you remained below this threshold for 0 days, which gives you 0 points of extra credit this week. Your threshold*

for this week will remain at 9.1. Be sure to leave the app open and to check it frequently to monitor your progress!"

STUDY 1 RESULTS AND DISCUSSION

Descriptive statistics were used to characterize the study samples prior to analyses. The mean age in the college sample was 22.1 years (SD = 0.99, range = 21.0 to 23.0). Results of the EARTH-Beta version are reported in Figures 4-11, and the participants weekly thresholds that they were required to remain below, are reported in Figures 12 and 13.

Six out of the eight participants had an overall increase in the frequency of when comparing the pretest to the post test, and the sum of the group resulted in an increase of 19. Conversely, participants have a decrease in the overall frequency of "no's" and "I don't know" when comparing the pretest to the post test. While future research is undoubtedly needed, this finding may be due to the fact that throughout the intervention, the participants increased their overall knowledge of pro and anti-climate related behavior and were able to appropriately answer each question.

As can be seen in Figure 3, only four participants completed all seven weeks of the study, and two of the eight participants were discarded from the changing criterion data analysis due to insufficient data (Participant 6 and 8; see Figures 12 and 13). Participant nine did not enable GPS tracking and as a result was unable to receive accurate annual thresholds. In addition, participant six missed three out of the seven submissions, and consequently was taken out of the overall data analysis within the changing criterion design. Generally speaking, when looking at the graphs together, there is an increasing trend in baseline for participants 1, 3, 5, and 8, and this can be explained through Missouri State's spring holiday and many participants driving home or driving/flying for a vacation.

Participant one started the intervention with the threshold of 19.2 tons and had an initial drop of 1.3 tons before dropping again by another 5.1 tons. Participant one was unable to remain the threshold of 12.8 for three weeks before eventually dropping to 12.3 tons during the final week. Participant two did not submit the initial documentation and as a result started the intervention with a threshold of 12.3 tons before decreasing to 11.9 tons, and then during week 4, participant 2 received a new threshold of 11.4 tons that they were unable to remain below for the reminder of the study. Participant three started the intervention with a threshold of 17.7 tons and dropped by 2.5 tons down to 15.2 tons where they remained for three consecutive weeks before dropping an additional 0.2 tons for the final week. Participant four began the intervention with a threshold of 9.4 and was unable to remain below this threshold following the baseline phase until week 6 where their threshold decreased to 9.0 where it remained until the completion of the study.

Participant five began the intervention at 18.5 tons and was steadily decreasing each week. They initially dropped by 1.9 tons to 16.6 tons, followed by a decrease of 2.5 tons and then another 3.5 tons to reach a threshold of 10.6 where they remained for the final two weeks of the study. Participant six started baseline at 11.0 tons, however they did not submit their weekly graph during the second week of baseline. Participant seven started the intervention at 14.0 tons before initially dropping down to 10.5 tons where they remained for one week before dropping down to 6.2 tons followed by 5.4 tons. Lastly is participant eight, who was unable to remain below their initial threshold of 9.1 tons during any of the weeks of intervention. During the intervention, participant eight reported having no difficulty with the application nor the graph provided within the app itself. However, following the visual analysis of the data, the participant

clearly did experience several difficulties which I will explain in the results section of study two: the qualitative interview component of the study.

The quantitative intervention in general did not appear to be effective for the majority of participants, despite the gradual decreases in score seen throughout some of the participants. The criteria that were set for this component of the study was completed using a data extractor tool (WebPlotDigitizer). This data extractor utilizes the individual data points already displayed in the line graph format and extracts each participant's data points via the extraction process from the annual footprint graphs extracted from the LiveGreen application.

STUDY 2 METHODS

Participants and Setting

The same eight participants that completed the intervention took part in the qualitative interview. At the beginning of the participant's normally scheduled class, the qualitative interview component of the study was described to the participants. The interviews were conducted by two separate experimenters stating the purpose of the interview, the additional extra credit points offered to participants as well as reinforming them of their right to withdraw from the study without penalty with the following statement:

> *"We are seeking to evaluate the potential efficacy of the incentive program that you completed over the course of the last several weeks. Extra credit in this graduate psychology course was used as an analogue to financial incentive programs that could be adopted in companies and assisted by the use of the app. Results in general failed to show a decrease in carbon emissions for most participants in the study. We want to obtain your perspectives about barrier to reducing emissions, the perceived efficacy of the incentives in the class and embedded in the application, ease of participation in the program, and values associated with climate impact. If you decide to participate in the interview, your course instructor has agreed to provide you with six additional extra credit points in this graduate psychology course. If you decide not to participate, decide to participate, and change your mind, or stop participating in the study at any time, your course instructor will provide you with an alternative extra credit assignment that will require the same time commitment."*

Throughout the participants regularly scheduled class period one-on-one interviews were had with each participant separately through Zoom each interview was audio recorded separately through the Zoom's audio recording function.

Materials

The interview questions were open-ended, and they were guided by a semi-structured interview guide. The open-ended interview was structured to reduce interview bias or prompting and to allow the participants to describe their experiences and perceptions from their own perspectives and reflected their priorities (Pearce et al., 2009). For example, participants were asked to describe potential barriers they have encountered in reducing their carbon footprint throughout the research study, rather than asking how climate change affects or might affect them.

A semi structured interview guide was developed in order to evaluate the potential efficacy of the incentive program that the participants completed. This interview guide consisted of four main topics: (1) potential barriers to reducing emissions; (2) the perceived efficacy of the incentives in the class and embedded in the application; (3) ease of participation in the program; and (4) values associated with climate impact. These topics were introduced using five main questions, each with anywhere from one to three follow up questions. Eight semi-structured interviews were conducted using the interview guide, one per participant, and the interviews lasted between 17 and 27 minutes. The entire interview guide is listed in Appendix D.

All participants were interviewed during their regularly scheduled class time, which took place on April 20th, 2022. The interviews were conducted via Zoom, with both the interviewer and the participants cameras and microphones turned on.

Procedure and Data Reduction

The interviews were conducted during the participants regularly scheduled class and were conducted by two researchers. The participants were randomly assigned to one of the experimenters to complete the qualitative interview. Once the participants joined the Zoom meeting room, the researcher read the statement listed above and then began the interview with the interview guide listed in Appendix D. Each question took approximately 5 minutes, and each interview was held to a time limit of 30 minutes. Researchers were instructed to ask the primary question as stated (numbered) and use prompt questions listed below as needed (letters). Researchers were also informed they were permitted to provide clarification where necessary not to deviate from the interview guide.

The audio interview filed were transcribed using a program titled TranscribeMe. The transcriptions were then reviewed and corrected by one researcher (MM) to ensure that they were transcribed verbatim. The interviews were then input into a mixed-methods program titled Dedoose (Dedoose Version 9.0.17) to conduct the qualitative thematic analysis. After reading the transcriptions from all of the interviews, one researcher (MM) coded all of the interviews and two experimenters (JB, and LH) independently coded half of the of the interviews, but they did not code the same half.

The creation and application of codes is the first step in qualitative "interview" analysis, (Bryman, 2007). To create codes and categorize data, the full transcript is required, and from

there the researcher can begin to look for codes throughout these transcriptions. In line with this, a code can be a word or a few words that stand in for a concept or topic. Additionally, the coding process is divided into three stages: open coding, where the initial raw data must be made sense of, axial coding, where the connections or ties between the categories of codes are found, and selective coding, where the categories can be linked together to construct a narrative (Bryman, 2007). Two rounds of constant comparison analysis were used for code development and application. All eight transcripts were coded during the first round of open coding using the initial categories provided by the interview guide as well as initially developing themes (Ryan & Bernard, 2003). Then, in order to determine the similarities and differences between the codes, these themes were examined and improved utilizing constant comparison approaches.

This open coding resulted in 140 thematic codes (e.g., “visual feedback felt rewarding”, “limited transportation options at work”, or “cannot control others”). The 140 codes were then written on individual sticky notes and placed onto an empty table to begin the affinity diagram process (American Society for Quality; ASQ, 2022). One researcher (MM) read each annotation that had been written one additional time before moving the sticky notes from the open table to a blank poster board. The same researcher then grouped sticky notes of similar nature using proximity of placement and added descriptive labels written on larger sticky notes to note any potential emerging overarching themes, see Figure 14.

Once all of the sticky notes had been sorted into groups, one researcher paused to re-read all of the sticky notes to ensure each annotation was placed in a group with similar annotations. Annotations were moved to another group if necessary, or a new group was created. Discussion between researchers was then completed and this was done by one researcher (MM) sending a picture of the poster board to the remaining two researchers (JB) and (LH). Any disagreements

that were found following the coding process were discussed with all of the co-experimenters until an IOA of 100% was reached. Following this, all of the relevant codes were grouped and organized into potential themes (MM) before having all three experimenters (MM, JB, and LH) review the themes in order to ensure that each theme was coherent, clearly distinguished, and that no codes were left unaccounted for. Finally, the themes were named and defined (MM) and then discussed and agreed upon by all experimenters (MM, JB, and LH).

From this, the codes resulted in five major categories: (1) solutions, (2) barriers, (3) perceived climate impact, (4) perceived positive intervention aspects, and (5) other pro-climate behaviors.

STUDY 2 RESULTS AND DISCUSSION

Following the completion of the qualitative interview analysis, three overarching themes become apparent: (1) barriers to reducing emissions, (2) behavioral influence, and (3) influence of values.

Theme 1: Barrier to reducing emissions.

Theme 1 was defined as any perceived barriers outweigh perceived individual impact. Actions by the individual are considered to be less important than the collective action as it feels like there is little control if left to the individual alone. This theme can further be broken down into two major categories: barriers and solutions. This theme was observed throughout the analysis as actions by the individual that were considered to be less important than collective action. Further, participants often reported as feeling like they have little control over the reduction of their carbon emissions due to variables outside their control such as driving to and from work or school:

> "*Driving is definitely the kicker, because up here, I live 35 miles away from my job, and going there five days a week, six days a week, something like that. Five days a week, driving there and back and then also standing in traffic in big city traffic, you sit and you're just in your car for a really long time, let alone in this year of just moving up here, I put, like, 30,000 miles on my car. And so, this life change has definitely increased my carbon emissions*."

For some of the participants like the one previously listed, they experienced a barrier to reducing their carbon emissions due to previous obligations requiring them to drive frequently and for extended periods of time. While driving was reported to have significantly increased participants overall carbon emissions, participants also reported having a difficult time reducing their emissions stemming from their utilities. This idea can also be seen through a statement from one participant regarding their overall consumption of utilities:

> *"I think my two biggest things, like my two biggest emissions, were utilities and travel. And right now, I live in a house that's over 100 years old, and it doesn't hold any heat. It doesn't hold cool air. Like when the weather's changed, we try to keep our air off as much as we can. But last month we did that a lot. Now that it's getting hotter, we've had to turn on the cold air again. But if it cools down, we'll turn it off. So pretty much those two things are what was hardest for me to keep in check just because I don't want to sleep in a hot house. And also, sometimes I have to travel with my own car by myself."*

While the participants described a number of barriers faced throughout the intervention, the participants also had a great deal of solutions provided to the research team during their qualitative interview. For example, one participant reported:

> *"I think it's really important because there are some things that we can do as people, not as corporations. We can still do our part within. To actually impact climate change or changing behaviors that are creating those high emission things is really important."*

Theme 2: Behavioral influence.

The second theme was defined as any behavior that is easy to change however is one that impacted carbon emissions the least. Similar to the first theme, Theme 2 was observed throughout the analysis as instances in which participants reported pro-climate behavior that they engaged in that did not make a meaningful difference in their weekly eco-feedback graphs:

> *"Driving did increase it, but I could never like, get it to decrease by changing my action. So, it would always increase by just like a trip or something. But walking more, doing any of the activities that got the points didn't really reduce it."*

One participant noted that significant change in the Earth's climate the present state of the Earth's climate may not improve without people of power decide to fight against the issue of climate change:

> *"Sure, it's great when people try to reduce their own emissions, but nothing's really going to change until those big companies like the oil companies or like, our own government or like, you know, people like Jeff Bezos, Elon Musk actually decided to make a difference instead of buying Twitter until the people way up high try to make a difference or start caring about the environment."*

Similarly, another participant stated that despite their increase in pro-climate behaviors, there were factors that worked against these behavior changes:

"I definitely think it's super important. And I feel like while l I didn't necessarily decrease my carbon footprint because of a lot of different factors, just like driving for work and stuff, I definitely looked at the app every single day and looked at my goals and I was putting in an effort to see what I could do to reduce my footprint."

Theme 3: Influence of values.

The final theme was defined as influencing climate change and reducing individual carbon emissions would require major change in lifestyle and conflict with other personal values. For example, one participant reported having interest in engaging in more pro climate related travel behavior (i.e., walking or biking in place of driving) however, they reported having prioritized other values:

"I don't think it's like at the top of my values right now. I know it's better to bike to class, but I feel like I have no time. So, I'm like, oh, I would really like to do that, but I really need to drive and get there in like ten minutes. I don't think it's at the top of my values. I think in the summer I think I could work on it a lot more with the timing right now."

"*Like, when I was driving home, it was usually to see my family, and that is like a pretty big value to me. So, if I didn't drive home, I wouldn't get to see them. I don't get to see them that often, so that is important. And a lot of the times when I was driving here was to pick up my professor. And I guess it's because I value education in that kind of way. Like, I was helping him and getting to work and getting to my GA spot by doing that, if that makes sense."*

Additionally, Theme 3 can be seen especially during week two, with many participants reporting having traveled home or traveled for vacation resulting in a sudden increase in carbon thresholds.

> *"I feel like the hardest thing that I did that I had happened was I had to drive home a few times, and as soon as I drove home once, it skyrocketed my score. But usually on the weeks where I didn't go home or I didn't really do much, I was fine."*

The results of the present study indicated that the incentivization, both through extra credit and through the planting of trees within the application itself led to varied levels of motivation, as well as an increased number of obstacles the research team had to overcome. The first example of this being participant submission difficulties, not to mention ensuring that the application stays open on the background of their phones.

GENERAL DISCUSSION

To restate, the purpose of the target study was to evaluate the combined effects of incentivization and self-monitoring on pro and anti-climate behavior using two commercially available applications. However, this component of the study was not supported throughout the statistical analyses and while future research is always needed, there are some potential explanations for this. The first being the selection of graduate students. The selection of this population was done intentionally however the present group of graduate school students may be a limitation considering seven out of the eight of the participants reported the extra credit earned within the application was not motivating enough to incite significant behavior change because the participants already had a good grade in the class.

One participant did report that the extra credit earned from the incentive program was successful in motivating their pro-climate relations as they had a significantly lower grade than the remaining seven participants. This proves that the usage of incentivization on proclinate behaviors will work if two things are held true; individuals are being paid enough to make the behavior work, as well as if people already exist in a relatively empty economy (i.e., they are already poor). However, this provides researchers with an ethical dilemma in that the creation of a contrived economy in which individuals do not have enough money, and then they have to engage in pro climate behaviors in order to then have enough, is not entirely ethically sound. In addition to the fact that poor people are not the ones making the biggest impact on the problem of climate change.

The purpose of the qualitative thematic analysis was to obtain the perspectives of the participants about barrier to reducing emissions, the perceived efficacy of the incentives in the

class and embedded in the application, ease of participation in the program, and values associated with climate impact. Extra credit was used as an analogue to financial incentive programs that could be adopted in companies and assisted by the use of the app. The present study applied this same idea to determine the effect that incentivization had on the participants pro-climate behavior. Incentivizing appropriate behavior does not adequately address the function of that behavior. Meaning that yes, we can incentivize behavior that we hope to see in the future, however if we do not determine nor address the overall function of said behavior then we cannot hope to see the decrease in behavior long term. This is idea is similar to giving reinforcers and is no different than giving stickers or Skittles for doing the right thing but does not deal with the actual functional context in which these behaviors occur.

Policymakers, companies, and individuals need to look for ways to slow the environmental damage that has already occurred and will continue to occur as we move closer and faster toward the global point of no return in which efforts to reduce climate change (i.e., carbon emission reduction) will no longer be sufficient in reversing the problems of the Earth's climate (Aengenheyster, Feng, Van Der Ploeg, & Dijkstra, 2018). Although the present study was unable to achieve a significant finding regarding participant's pro-climate behaviors, there were several other prominent findings throughout the data analysis that should be noted. First and foremost, human decision making is vastly complex, and often times forces individuals to make a choice between one of two values which is a common theme throughout the entirety of the interview transcriptions. A consistent trend throughout the interview analysis was the degree to which participants would report having difficulty engaging in pro climate behaviors, with very few of these difficulties being perceived to be personal barriers to reaching these goals. For example, Participants reported driving having a large impact on the increase of overall carbon

emissions, however participants did not report significant reduction in driving when discussing decreases in carbon footprint.

Qualitative interviewing has a unique opportunity to provide researchers with an additional perspective of the participants upon the completion of a research study, with particular emphasis on null findings. While quantitative components of research provide the necessary information on whether an approach is statistically significant or not, it is unable to touch on the direct experiences of the participants themselves nor is it able to provide the necessary feedback in order to correct any shortcomings found throughout the intervention. The utilization of a mixed methods research design can be particularly compelling when dealing with the overarching enigma of human behavior in that it has the ability to bridge two different approaches (quantitative and qualitative) while simultaneously utilizing the strengths of both methods, and ideally minimizing the shortcomings that exist for each.

However, no study is without its limitations, with the first in this study being the use of a non-representative convenience sample. While a college classroom was used in the present study due to its resemblance toward a closed economy, the sample was made entirely of white women between the ages of 21-23. Future research in this area would benefit from a more representative and diverse sample of participants, and there may be some utility in comparing results from the United States to those of different countries. In addition, future research may find utility when focusing on targeting the younger populations due to the fact that many individuals, struggle to make large behavioral changes in their day-to-day lifestyle seeing as those behaviors have been held consistent over several years potentially decades. This idea could be beneficial in both the school setting as well as with undergraduate populations. The use of graduate students was done for two main reasons the with the first being for convenience, and the second being that graduate

students belong within a closed economy meaning the researchers were able to incentivize pro-climate behaviors.

Future research may also consider implementing a fidelity measure or potentially scheduling a check in with participants to ensure that their cellphones have enabled GPS tracking and that they are consistently entering in the appropriate picture for the weekly submissions. Further, there was one week (Week 5) where participants were required to submit the necessary documentation despite the class being cancelled, and the participants were prompted to submit their documentation through an alert on ExpiWell. Even though they had been previously trained on how to submit the appropriate documentation, and were provided with the task analysis, there were still some participants that did not submit during Week 5. In addition, an increasing trend was observed in baseline, and future research should consider extending the baseline to ensure that the initial threshold provided to participants is one that can be attained without the effects of frustration, or hopelessness.

Even though the null findings of this study resulted in a qualitative interview, the eco-feedback intervention the results in general failed to show a significant decrease in carbon emissions for most participants in the study. Future research may find utility in modifying the present study to evaluate values driven, intrinsic motivators to increase pro-climate behaviors. Previous research has shed light on the idea that intrinsic motivators are significantly more motivating as a whole, and the effect of their motivation produces a lasting effect (Pugno & Sarracino, 2021). Despite the fact that intrinsic motivation seems to be more incentivizing for pro climate behavior, it is not entirely clear how to compare and contrast these effects with the extrinsic motivation described in the present study. There may be some advantage in uncovering the difference between the usage of intrinsic and extrinsic motivation.

One limitation that often comes with qualitative research is the possibility of interviewer bias. Respondents give socially acceptable answers rather than honestly answering questions because they are unable, unwilling, or afraid to do so. As a result, it's possible that some individuals gave an overly positive assessment of themselves. When the interviewer's attitudes and expectations unintentionally or actively impact the respondents' responses, the interviewer bias can also go in the opposite direction. Although we made every effort to be neutral and objective in our questioning and answer-interpreting, we cannot completely rule out the possibility that the respondents' responses may have occasionally been influenced by our views and opinions on the use of NHST. This may have resulted in some of the previously listed qualitative results.

Climate related research and applications are constantly developing and evolving, and it is crucial that the science of human behavior continues to evolve alongside these evolutionary changes. A common theme throughout the qualitative interview analysis, was the idea that individuals were willing to engage in pro climate relations when there were no additional demands being placed upon them. For example, one participant reported experiencing some difficulty walking to and from class especially in extreme weather (rain, heat, and snow) however they report an increase in these behaviors during favorable weather conditions. This is a significant, but disturbing finding because while yes changing one’s own lifestyle can sometimes be challenging, so too are the catastrophic climate-related events that have already occurred, are going to continue to occur, and will only increase in severity if we as a science as well as individuals make the decision not to act now.

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Table 1. List of the five various eco-feedback applications considered for the present study currently available for consumers.

Application Name	**Pros**	**Cons**
Capture	Shows app users with a graph where they rank regarding carbon emissions There is a learning tab helps provide information on carbon emissions Miles driven and walked are automatically tracked Users can edit the type of travel (carpooling/type of car and gas)	Can't add information (diet, activity, habit building) Manually add in food information Have to pay to offset emissions through their projects Levels are very subjective
EcoCred	Measure and pinpoint the amount of CO_2 to offset each day Provides users with different habits and the climate related information about each There is a community feed where users can post and read other people's comments There is an additional resources tab	Advertisements In order to plant trees to supplement CO_2 emissions, they have to be purchased. All data is entered in by the users manually
Eevie	Provides its users with habit nudges Utilizes a prosocial component Provides its users with facts about their climate related habits Organizes users' habits based on their overall function Allows users to virtually check in on their trees	Tree seedlings can only be earned by inviting new users or by purchasing them All data is entered in by the users manually Geared toward businesses rather than individual consumers
Joulebug	Utilizes clear goals and habits to complete in order to reduce emissions Users can compete with their friends	Manual habits can be difficult to remember to track Does not send users notifications There is no cash out from the points within the app

Table 1. continued.

Application Name	Pros	Cons
LiveGreen	Cash out points for trees to plant in real life Automatically tracks miles driven and walked via GPS The founder created availability to meet or contact him with ideas for future app development Visualization of where you rank in comparison to others as individuals as well as countries	Restricted habit tracking Must leave application open in the background of the users iPhone Only iOS compatible

Table 2. List of codes found during the qualitative interview analysis. Codes are organized per category.

Solutions	Perceived Climate Impact	Barriers	Perceived Positive Intervention Aspects	Other Pro-Climate Behavior
App improvements (trees)	Given up hope	Missed information (external factors)	Worth the effort	Doing other behaviors in the app
Extra credit explained deeper	Low importance	Context (place of living)	**P**lanting trees/ points in app felt rewarding	Showed app to friends/family member
Incentive more personalized	Eye opening	Changing eating difficult	Trees were more incentivizing	Checking app daily helped
More extra credit would help	Individual behavior makes no difference	Activities/goals not helpful	Visual feedback felt rewarding	Walking for more points
Money may be rewarding	Personal behavior impact (low)	Keeping app open	Continue planting trees	Walking for good health
Money to offset expenses	Do not see immediate impact	Not noticing carbon footprint change	Incentives felt rewarding	Animal product alternative and a dairy free diet
Need to benefit self and environment	Felt no control in decreasing footprint	Learning curve	Extra credit rewarding (needed points)	Carpooling
App more personalized	Climate value low	Confused about extra credit	Extra credit less confusing over time	Recycling
Daily app reminders	No control over external factors	Difficulty with app tracking driving	Task analysis was helpful	Reduce electric use
More features on app	Difficult to change	Context(neighborhood)	Extra credit system felt easy	Thrift store
Visual representation	Cannot control others	Participation effort	App was easy	Walking
Companies have most responsibility	Hard to stay below threshold	Graph not incentivizing (went up)	Keeping the app	Washing clothes
City-wide intervention needed	Need corporations to change	App was confusing	Enjoyed the app	
Collective action necessary	Important(ce)	App glitching		

Table 2. continued.

Solutions	Perceived Climate Impact	Barriers	Perceived Positive Intervention Aspects	Other Pro-Climate Behavior
Felt that talking to others helped	Awareness of climate related behavior	Flying was a barrier		
More education about climate	Important individually	Okay when no demands		
More accessible transit	Increased noticing of climate behavior	Easier in nice weather		
Driving alternatives	Greater change before submission	Extra credit not rewarding (good grade)		
Trying to reduce driving	Small changes matter	Cost		
Individual action still needed	Small change is easier	Energy inefficient utilities		
School responsibility	Climate value increased	On the go lifestyle		
Recycling/compost accessibility	Felt that intervention helped	Need/want to travel		
Alternative product	A little bit adds up	Safety		
Better schedule driving	Impactful if everyone does it	Time		
Better transit system	Personal impact	Need for society improvement		
Buy more sustainably	Pro-climate behavior (following intervention)	Pro-environment behavior not always an option		
Carpool		Driving major barriers		
Incentivize public transit		Limited transportation options at work		
Alternative options at work		Need to drive (work)		
More sustainable diet		Need to drive (home)		
Move somewhere else		Need to drive (other)		

Table 2. continued.

Solutions	Perceived Climate Impact	Barriers	Perceived Positive Intervention Aspects	Other Pro-Climate Behavior
Planting food Walking to campus		No incentive for workplace Climate is political Limited education information Others do not see it as a problem Impacting factor(s) Competing values (family) Competing values (work) Competing values (Leisure) Competing values (other) Driving alternatives not practical Need employee buy-in Others not contributing Value prioritization Other values more important Workplace wastefulness		

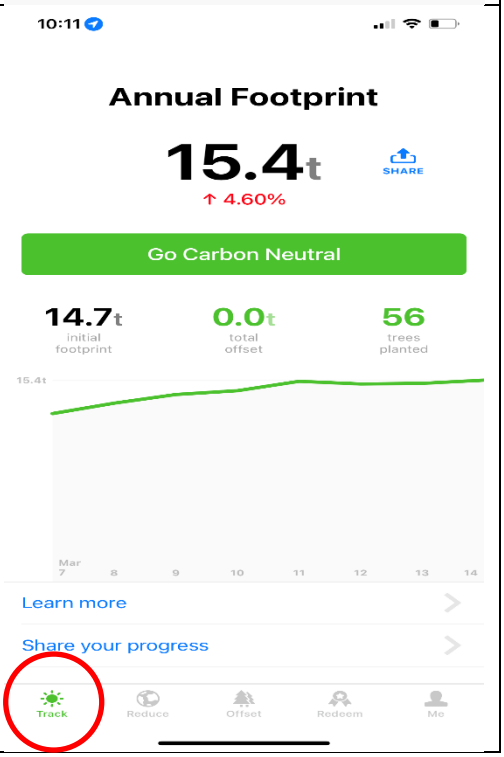
Annual Footprint Screenshot	
1. Open the LiveGreen App from your iPhone's home page.	
2. Click the "Track" tab on the bottom of the screen.	

Figure 1. Weekly eco-feedback submission task analysis

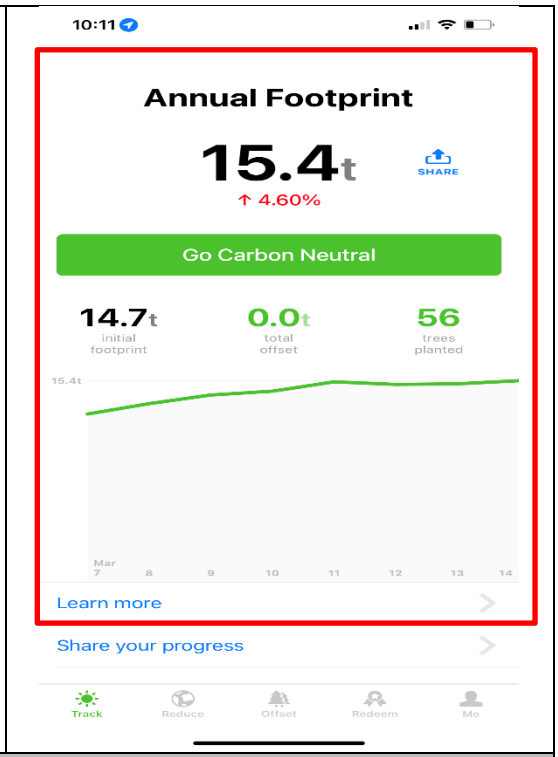
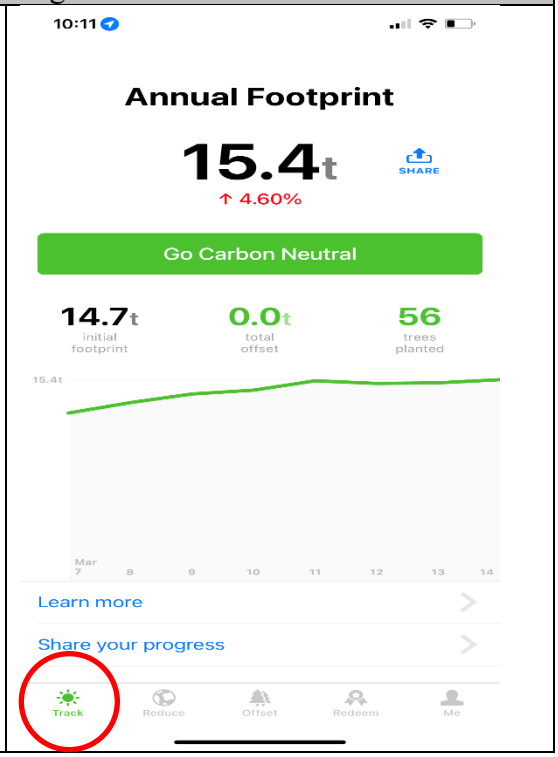
3. Screenshot the “Annual Footprint” photo	
Carbon Footprint Image:	
4. Click the “Track” tab on the bottom of the screen.	

Figure 1. continued

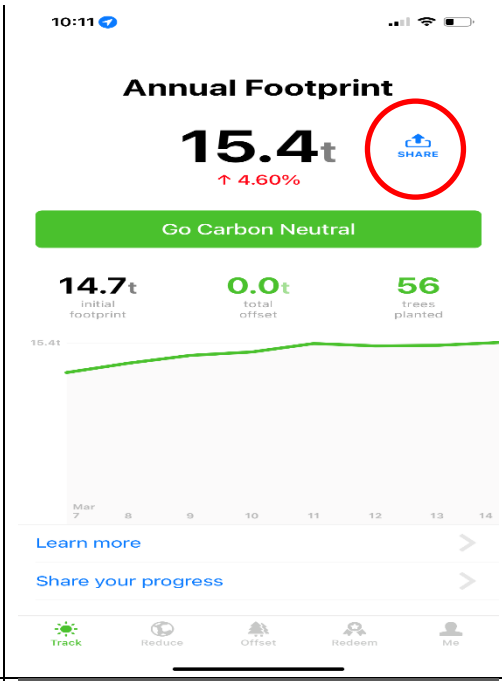
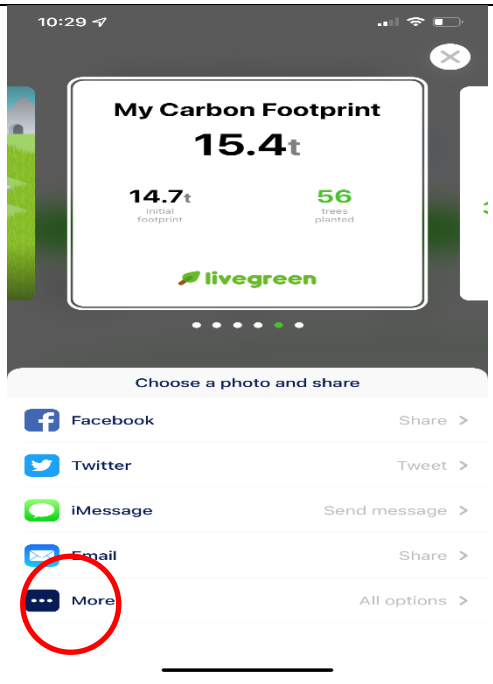
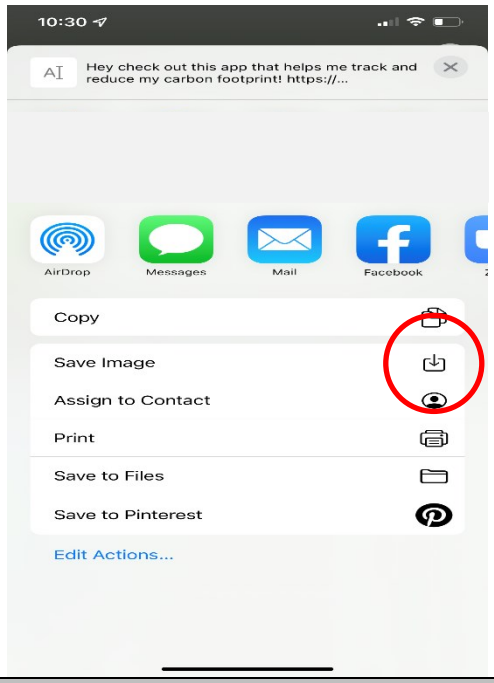
5. To the right of the numbers on the top of the page, click “Share”	
6. Swipe to the “My Carbon Footprint” photo. On the bottom half of the screen titled “Choose a photo and share” click “more”.	

Figure 1. continued

7. Then press “Save Image”



Trees Planted Screenshot

8. Click the “Track” tab on the bottom of the screen.

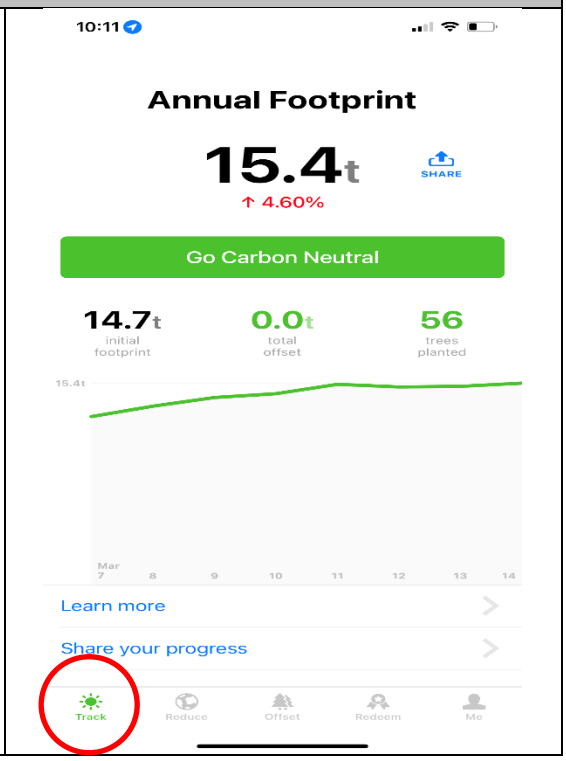


Figure 1. continued

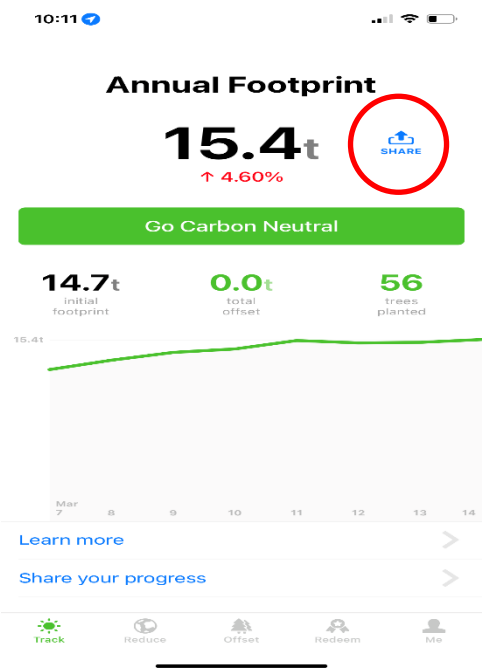
9. To the right of the numbers on the top of the page, click “Share”	
10. Swipe to the “I’ve planted XX trees! That’s the same as saving: ____” photo. On the bottom half of the screen titled “Choose a photo and share” click “more”.	

Figure 1. continued

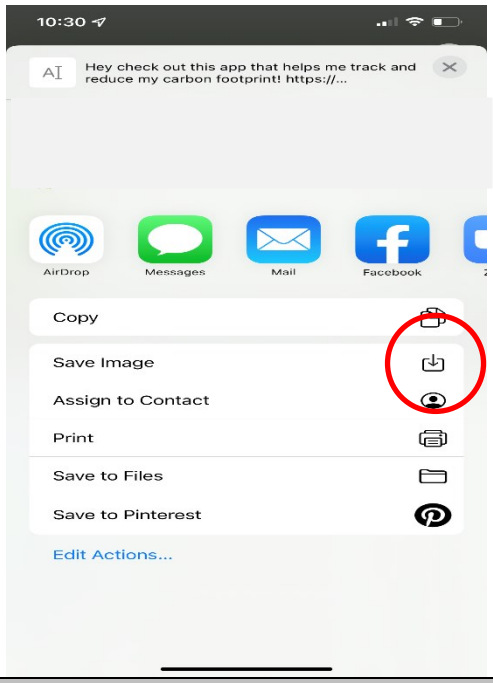
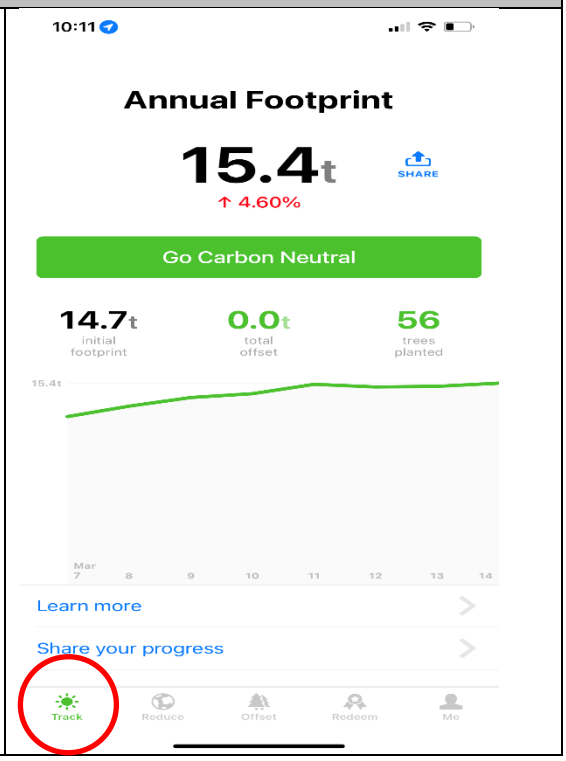
11. Then press “Save Image”	
Footprint Reduction Screenshot	
12. Click the “Track” tab on the bottom of the screen.	

Figure 1. continued

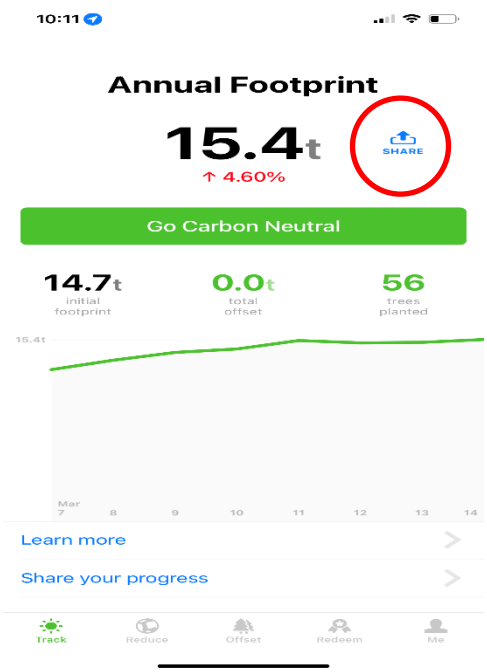
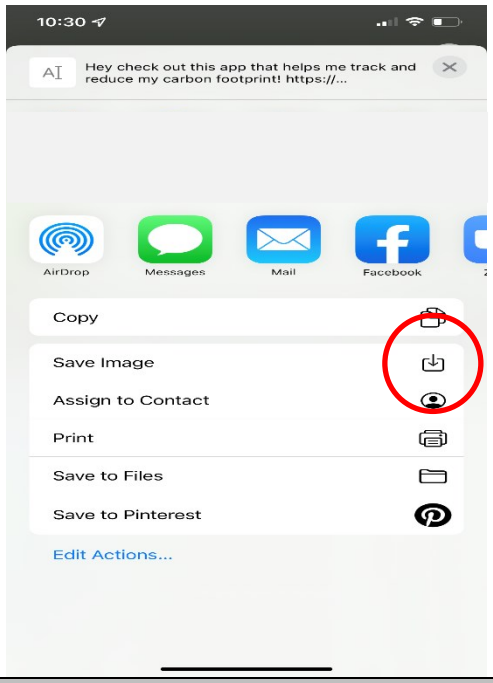
13. To the right of the numbers on the top of the page, click “Share”	
14. Swipe to the “I’ve reduced my footprint by XX tons so far!” photo. On the bottom half of the screen titled “Choose a photo and share” click “more”.	

Figure 1. continued

15. Then press “Save Image”



CO2 Saved Screenshot

16. Click the “Track” tab on the bottom of the screen.

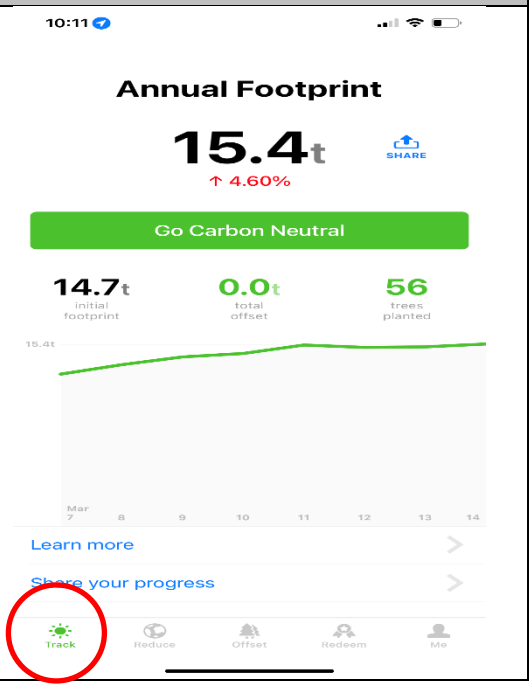


Figure 1. continued

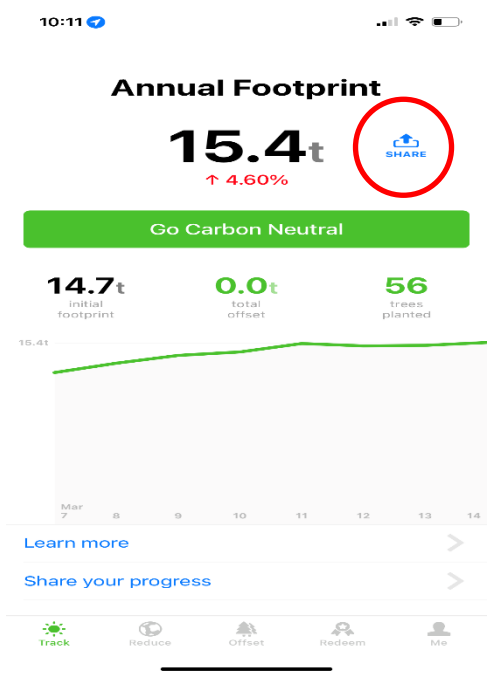
17. To the right of the numbers on the top of the page, click “Share”	
18. Swipe to the “I’ve saved 1,085 pounds of CO2!” photo. On the bottom half of the screen titled “Choose photo and share” click “more”.	

Figure 1. continued

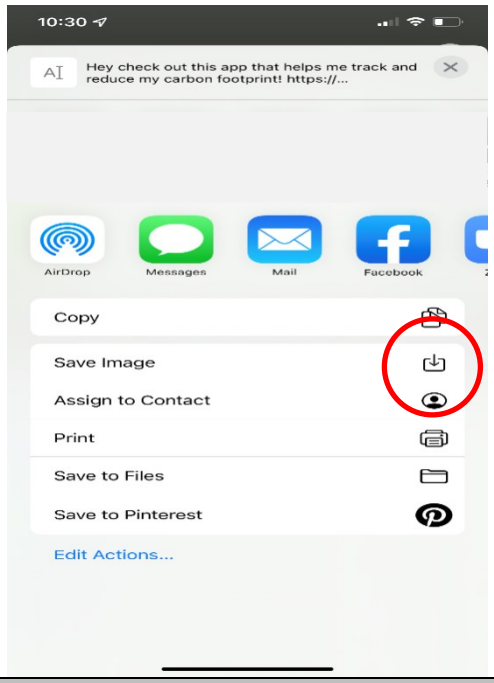
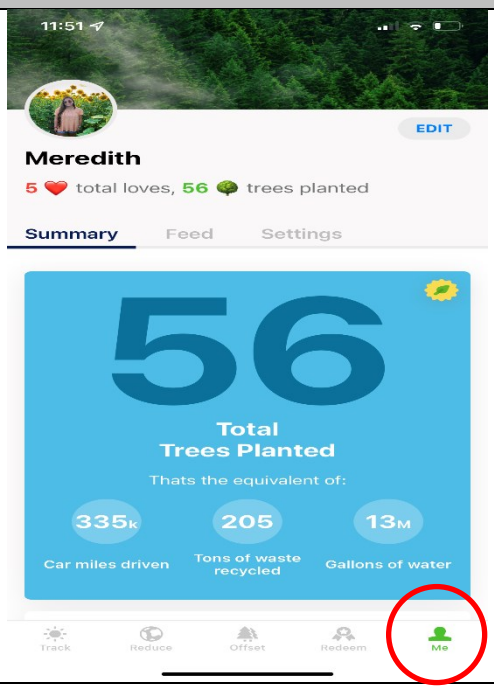
19. Then press “Save Image”	
Average Daily Emissions Screenshot	
20. Click the “Me” tab on the bottom of the screen.	

Figure 1. continued

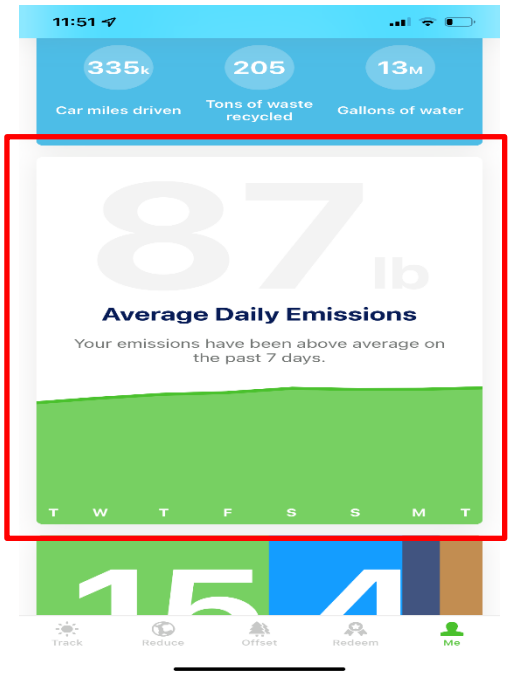
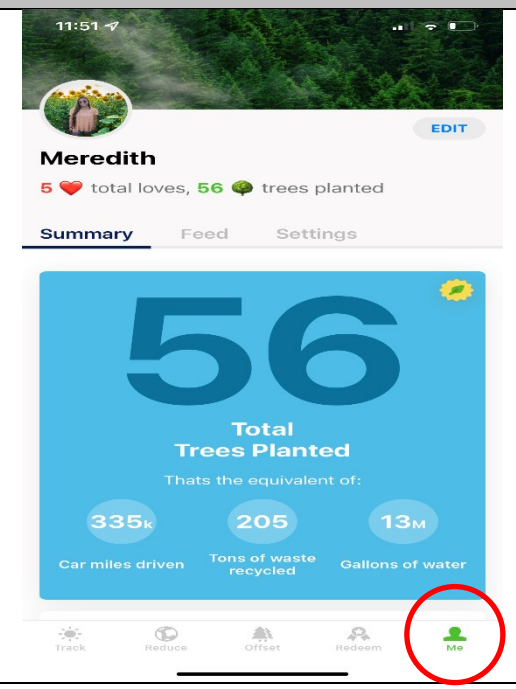
21. Scroll down to the “Average Daily Emissions” photo, and screenshot it.	
Estimated Annual Footprint Screenshot	
22. Click the “Me” tab on the bottom of the screen.	

Figure 1. continued

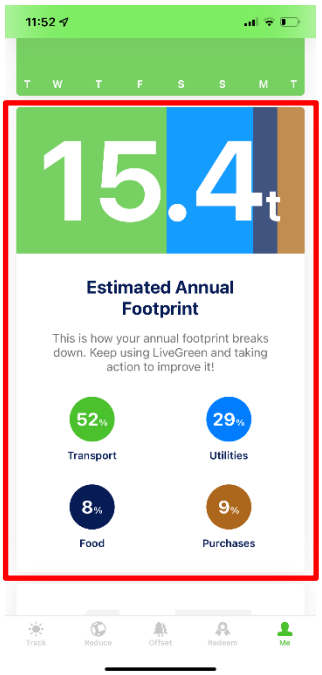
23. Scroll down to the “Estimated Annual Footprint” photo, and screenshot it.	
ExpiWell Weekly Questionnaire	
24. Open the ExpiWell App from your iPhone’s home page.	
25. Under “Available Experiences” click “Weekly Eco-Feedback Questionnaire”	
26. Click “Start”	

Figure 1. continued

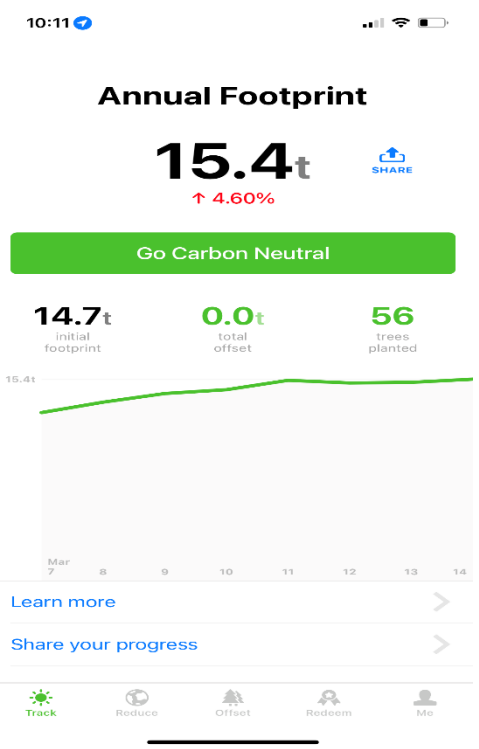
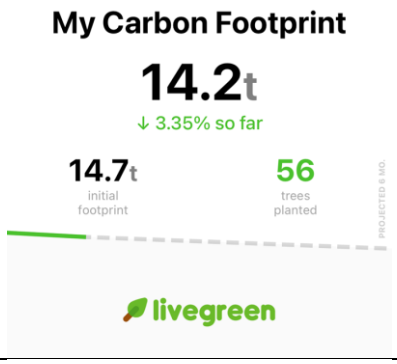
27. Insert your Annual Footprint Screenshot	
28. Insert your Carbon Footprint image.	
29. Insert your Footprint Reduction image.	

Figure 1. continued

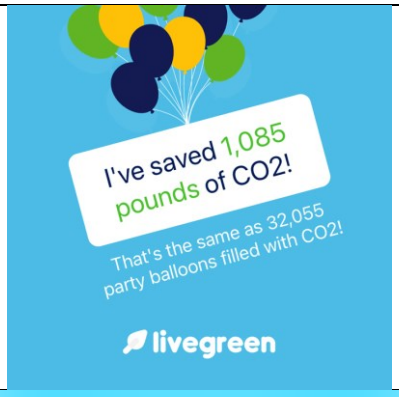
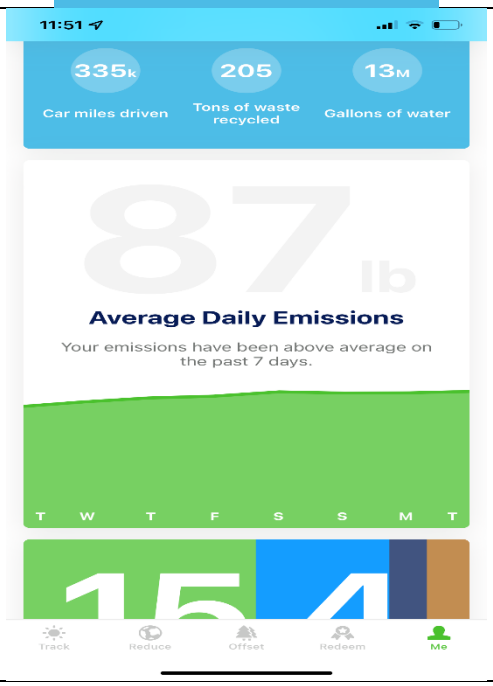
30. Insert your Trees Planted image.	
31. Insert your CO2 Saved image.	
32. Insert your Average Daily Emissions screenshot.	

Figure 1. continued

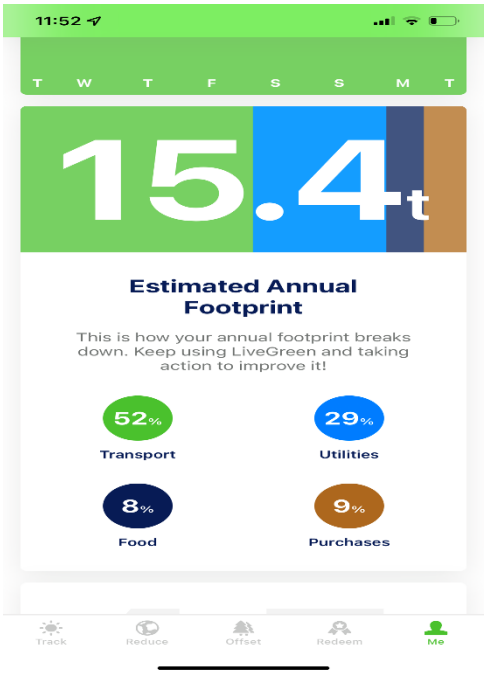
33. Insert your Estimated Annual Footprint screenshot.	

Figure 1. continued

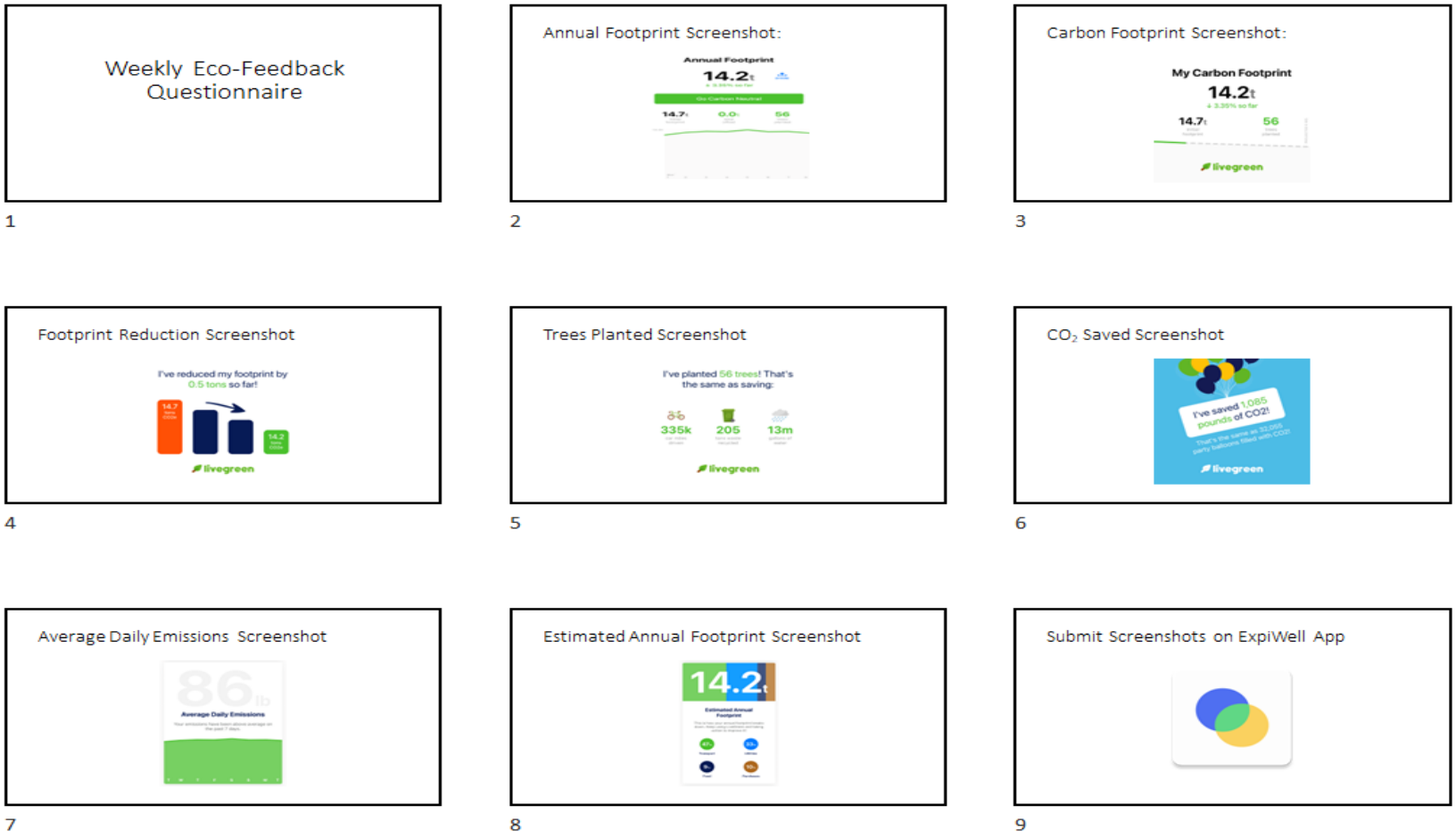


Figure 2. Supplementary PowerPoint presentation projected onto the front of the screen during the submission process each week during their regularly scheduled class.

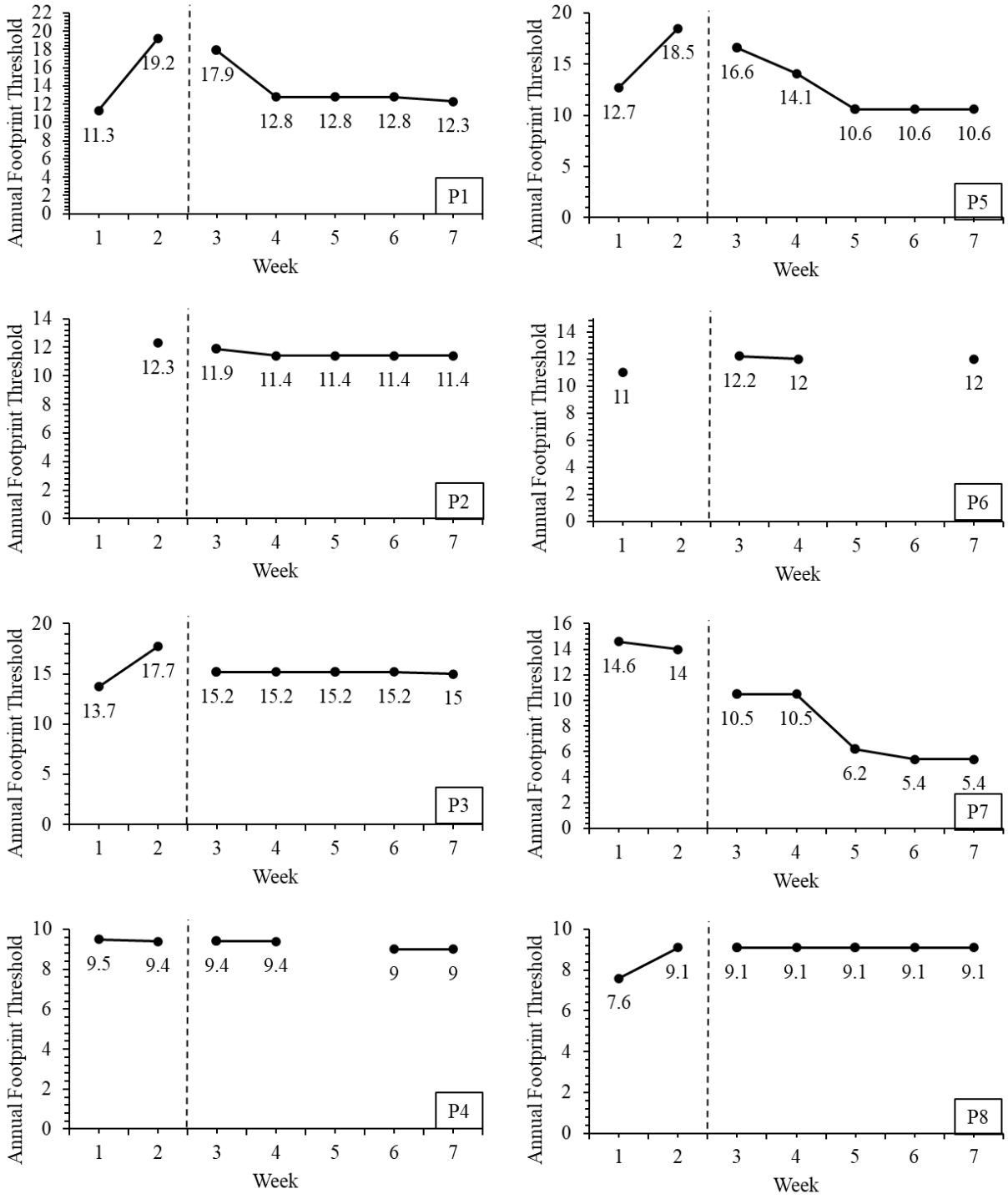


Figure 3. Annual Footprint Threshold's that the participants were required to remain below in order to receive extra credit in class. Each data point represents a new week of the intervention.

EARTH-Beta Version: Participant 1								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)	■	▒					
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)				▒	■		
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times	■			▒			
4	Water is turned off between dishes when washing dishes	■	▒					
5	Appeals to family to increase sustainability are made at least once per year	■	▒					
6	Water is mostly consumed from a reusable water bottle	■	▒					
7	All daily notes are recorded without paper	■			▒			
8	Appeals to friends to increase sustainability are made once a year	■	▒					
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)				▒	■		
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)				▒	■		
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly				▒	■		
12	Water is always consumed from a reusable water bottle	■	▒					
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times			■	▒			
14	Reusable containers are used when purchasing bulk produce	■	▒					
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■	▒			
16	Use only natural light in the middle of the day	■	▒					
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly				▒	■		
18	All purchased clothing is responsible, second hand or is worn more than 30 times			■	▒			
19	All purchased clothing is responsible, second hand or is worn more than 30 times			■	▒			
20	Food products in single-use plastic containers are avoided	■			▒			
	Total	11	8	4	12	5	0	
	Change Score	-2		+8		-5		

Figure 4. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 1. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 2								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)	■			■			
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■			■	
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times	■	■					
4	Water is turned off between dishes when washing dishes			■	■			
5	Appeals to family to increase sustainability are made at least once per year	■			■			
6	Water is mostly consumed from a reusable water bottle	■	■					
7	All daily notes are recorded without paper	■			■			
8	Appeals to friends to increase sustainability are made once a year				■	■		
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)				■	■		
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)				■	■		
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly	■			■			
12	Water is always consumed from a reusable water bottle	■	■					
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times	■	■					
14	Reusable containers are used when purchasing bulk produce	■			■			
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)				■	■		
16	Use only natural light in the middle of the day		■			■		
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly	■			■			
18	All purchased clothing is responsible, second hand or is worn more than 30 times		■	■				
19	All purchased clothing is responsible, second hand or is worn more than 30 times		■	■				
20	Food products in single-use plastic containers are avoided	■			■			
	Total	10	7	4	12	5	1	
	Change Score	-3		+8		-4		

Figure 5. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 2. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 3									
Question		Yes		No		I don't know	
		Pre	Post	Pre	Post	Pre	Post
1	At least 25% of house lights are energy efficient (e.g., LED, smart)						
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)						
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times						
4	Water is turned off between dishes when washing dishes						
5	Appeals to family to increase sustainability are made at least once per year						
6	Water is mostly consumed from a reusable water bottle						
7	All daily notes are recorded without paper						
8	Appeals to friends to increase sustainability are made once a year						
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)						
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)						
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly						
12	Water is always consumed from a reusable water bottle						
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times						
14	Reusable containers are used when purchasing bulk produce						
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)						
16	Use only natural light in the middle of the day						
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly						
18	All purchased clothing is responsible, second hand or is worn more than 30 times						
19	All purchased clothing is responsible, second hand or is worn more than 30 times						
20	Food products in single-use plastic containers are avoided						
	Total	8	11	6	8	6	1
	Change Score	+2		+2		-5	

Figure 6. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 3. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 4								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)							
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times							
4	Water is turned off between dishes when washing dishes							
5	Appeals to family to increase sustainability are made at least once per year							
6	Water is mostly consumed from a reusable water bottle							
7	All daily notes are recorded without paper							
8	Appeals to friends to increase sustainability are made once a year							
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)							
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly							
12	Water is always consumed from a reusable water bottle							
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times							
14	Reusable containers are used when purchasing bulk produce							
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
16	Use only natural light in the middle of the day							
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly							
18	All purchased clothing is responsible, second hand or is worn more than 30 times							
19	All purchased clothing is responsible, second hand or is worn more than 30 times							
20	Food products in single-use plastic containers are avoided							
	Total	7	14	10	6	3	0	
	Change Score	+7		-4		-3		

Figure 7. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 4. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 5									
Question		Yes		No		I don't know			
		Pre	Post	Pre	Post	Pre	Post		
1	At least 25% of house lights are energy efficient (e.g., LED, smart)					■	■		
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)		■	■					
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times	■	■						
4	Water is turned off between dishes when washing dishes	■	■						
5	Appeals to family to increase sustainability are made at least once per year	■	■						
6	Water is mostly consumed from a reusable water bottle	■	■						
7	All daily notes are recorded without paper	■			■				
8	Appeals to friends to increase sustainability are made once a year	■			■				
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■			■		
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)			■	■				
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly		■	■					
12	Water is always consumed from a reusable water bottle	■	■						
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times	■	■						
14	Reusable containers are used when purchasing bulk produce		■	■					
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■	■				
16	Use only natural light in the middle of the day	■	■						
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly		■	■					
18	All purchased clothing is responsible, second hand or is worn more than 30 times	■			■				
19	All purchased clothing is responsible, second hand or is worn more than 30 times	■			■				
20	Food products in single-use plastic containers are avoided			■	■				
	Total	11	11	8	7	1	2		
	Change Score	=		-1		+1			

Figure 8. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 5. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 6								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)							
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times							
4	Water is turned off between dishes when washing dishes							
5	Appeals to family to increase sustainability are made at least once per year							
6	Water is mostly consumed from a reusable water bottle							
7	All daily notes are recorded without paper							
8	Appeals to friends to increase sustainability are made once a year							
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)							
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly							
12	Water is always consumed from a reusable water bottle							
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times							
14	Reusable containers are used when purchasing bulk produce							
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
16	Use only natural light in the middle of the day							
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly							
18	All purchased clothing is responsible, second hand or is worn more than 30 times							
19	All purchased clothing is responsible, second hand or is worn more than 30 times							
20	Food products in single-use plastic containers are avoided							
	Total	2	7	15	8	3	5	
	Change Score	+5		-7		+2		

Figure 9. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 6. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 7								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)							
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times							
4	Water is turned off between dishes when washing dishes							
5	Appeals to family to increase sustainability are made at least once per year							
6	Water is mostly consumed from a reusable water bottle							
7	All daily notes are recorded without paper							
8	Appeals to friends to increase sustainability are made once a year							
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)							
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly							
12	Water is always consumed from a reusable water bottle							
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times							
14	Reusable containers are used when purchasing bulk produce							
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)							
16	Use only natural light in the middle of the day							
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly							
18	All purchased clothing is responsible, second hand or is worn more than 30 times							
19	All purchased clothing is responsible, second hand or is worn more than 30 times							
20	Food products in single-use plastic containers are avoided							
	Total	6	16	13	4	1	0	
	Change Score	+10		-9		-1		

Figure 10. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 7. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

EARTH-Beta Version: Participant 8								
Question		Yes		No		I don't know		
		Pre	Post	Pre	Post	Pre	Post	
1	At least 25% of house lights are energy efficient (e.g., LED, smart)	■					■	
2	25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)		■	■				
3	At least 25% of purchased clothing is responsible, second hand or is worn more than 30 times	■	■					
4	Water is turned off between dishes when washing dishes	■	■					
5	Appeals to family to increase sustainability are made at least once per year	■	■					
6	Water is mostly consumed from a reusable water bottle	■	■					
7	All daily notes are recorded without paper		■	■				
8	Appeals to friends to increase sustainability are made once a year		■	■				
9	50 percent of household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■			■	
10	50 percent of hygiene and or makeup products are natural (i.e., do not contain unrecognizable chemicals)			■			■	
11	At least 25 percent of new household purchases are recyclable, local or ecofriendly	■			■			
12	Water is always consumed from a reusable water bottle	■			■			
13	At least 50 percent of purchased clothing is responsible second hand or is worn more than 30 times		■	■				
14	Reusable containers are used when purchasing bulk produce	■			■			
15	All household cleaners are natural (i.e., do not contain unrecognizable chemicals)			■	■			
16	Use only natural light in the middle of the day	■	■					
17	At least 50 percent of new household purchases are recyclable, local, or ecofriendly			■			■	
18	All purchased clothing is responsible, second hand or is worn more than 30 times			■	■			
19	All purchased clothing is responsible, second hand or is worn more than 30 times			■	■			
20	Food products in single-use plastic containers are avoided			■	■			
	Total	9	9	11	7	0	4	
	Change Score	=		-4		+4		

Figure 11. Results of the Environmental Assessment of Responses Toward Habitability (EARTH) Beta Version

Participant 8. Pretest scores are represented through the filled in black squares. Posttest scores are represented through the filled in grey squares.

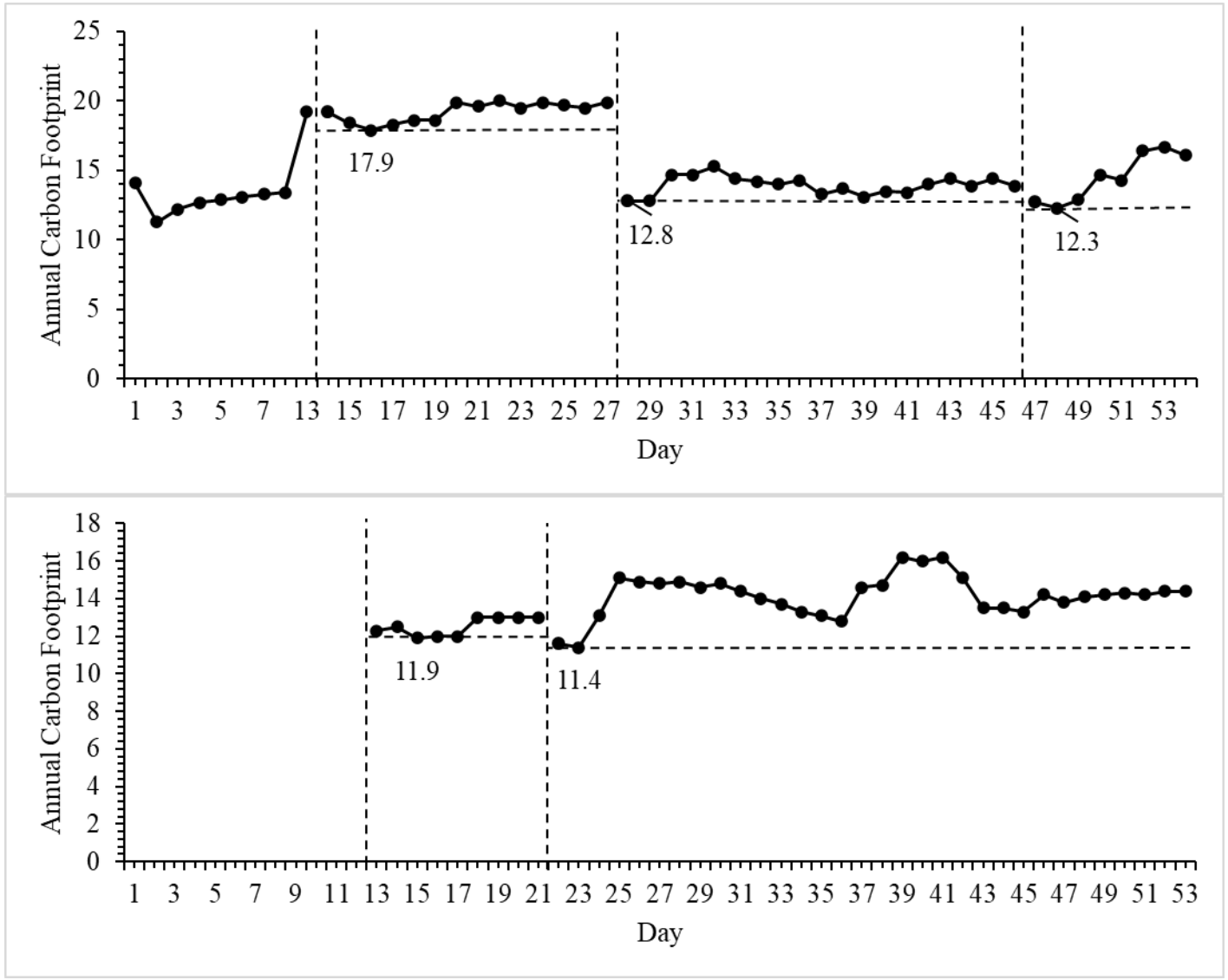


Figure 12. The frequency of days each participant was able to remain below their predetermined thresholds.

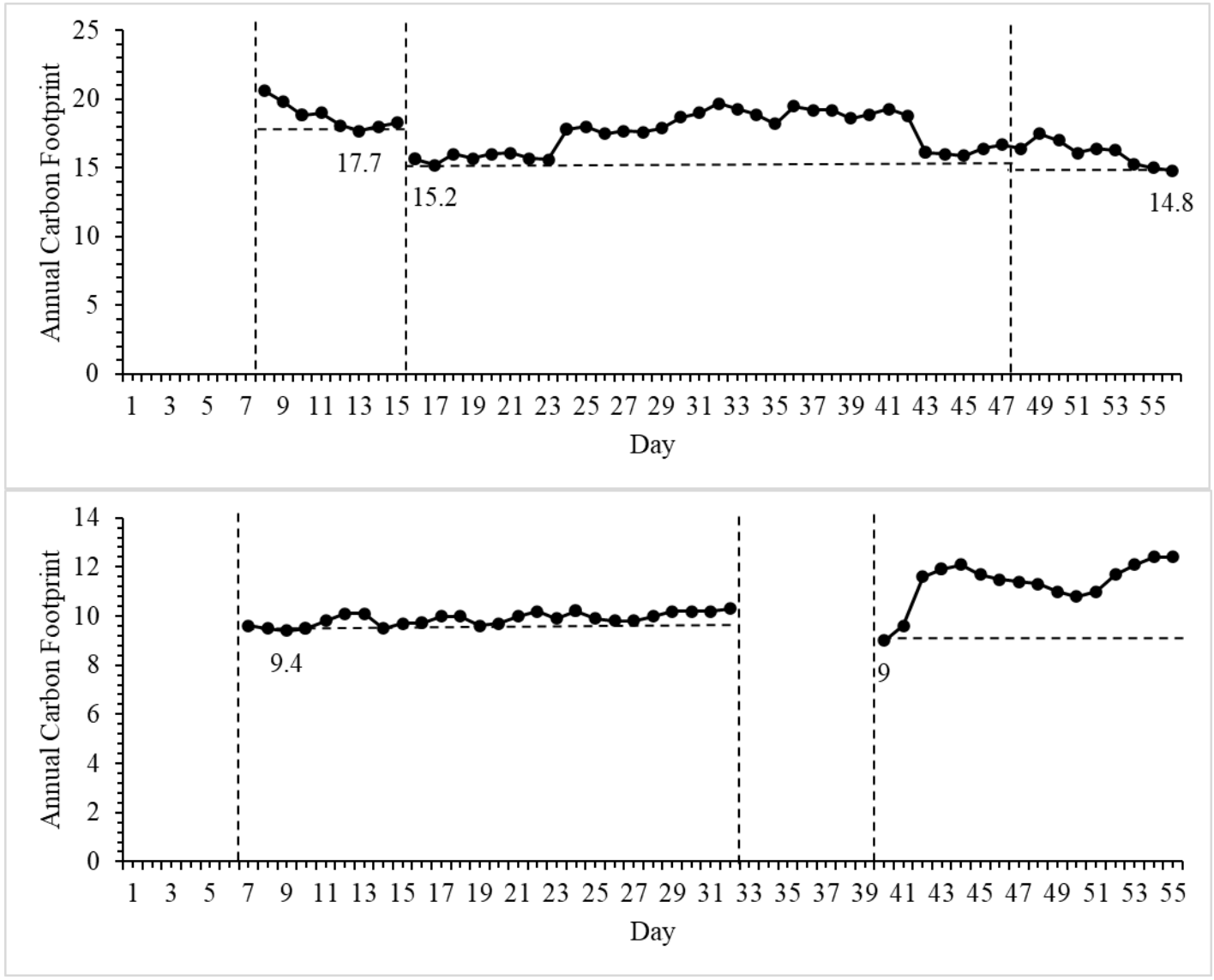


Figure 12. continued.

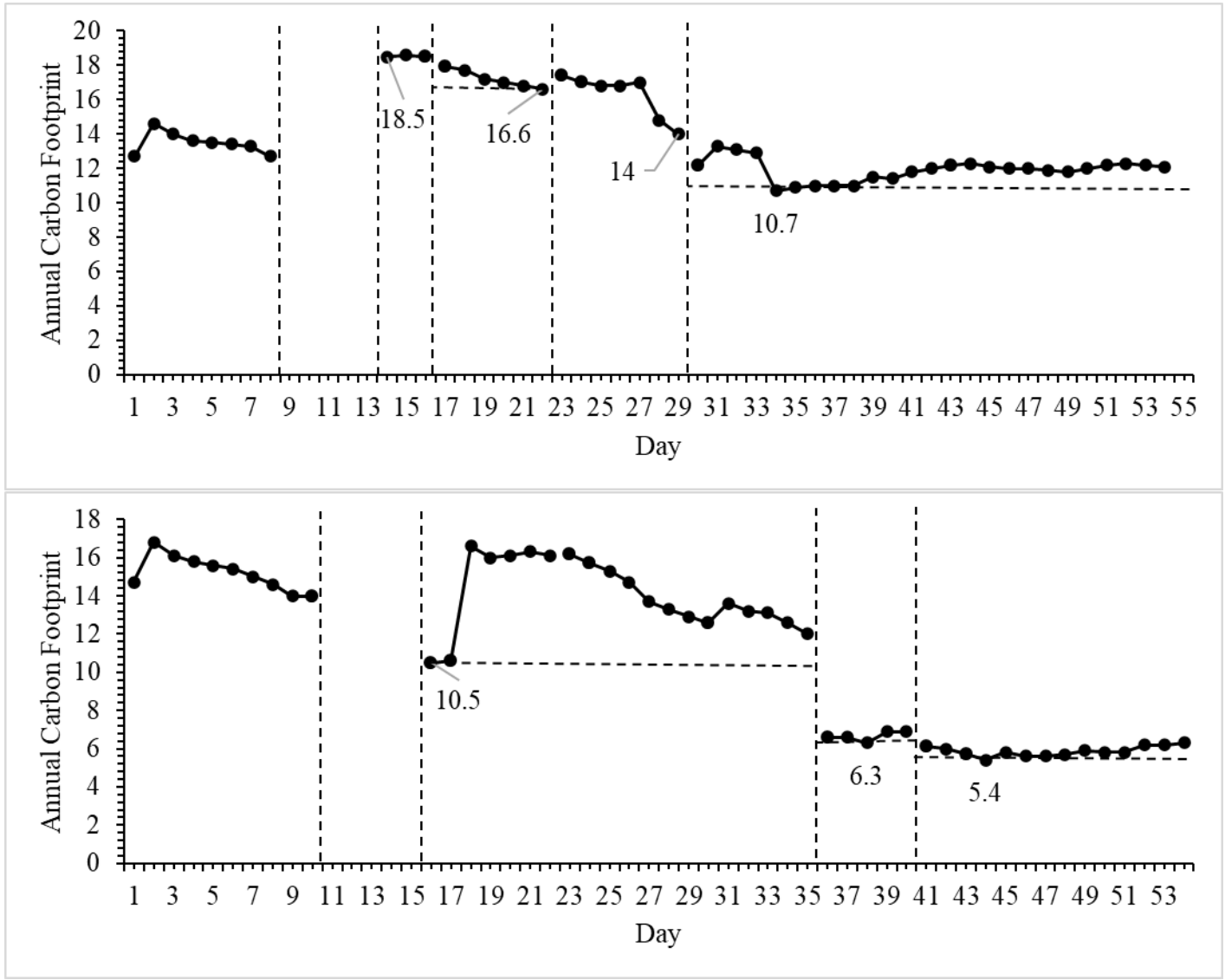


Figure 12. continued.

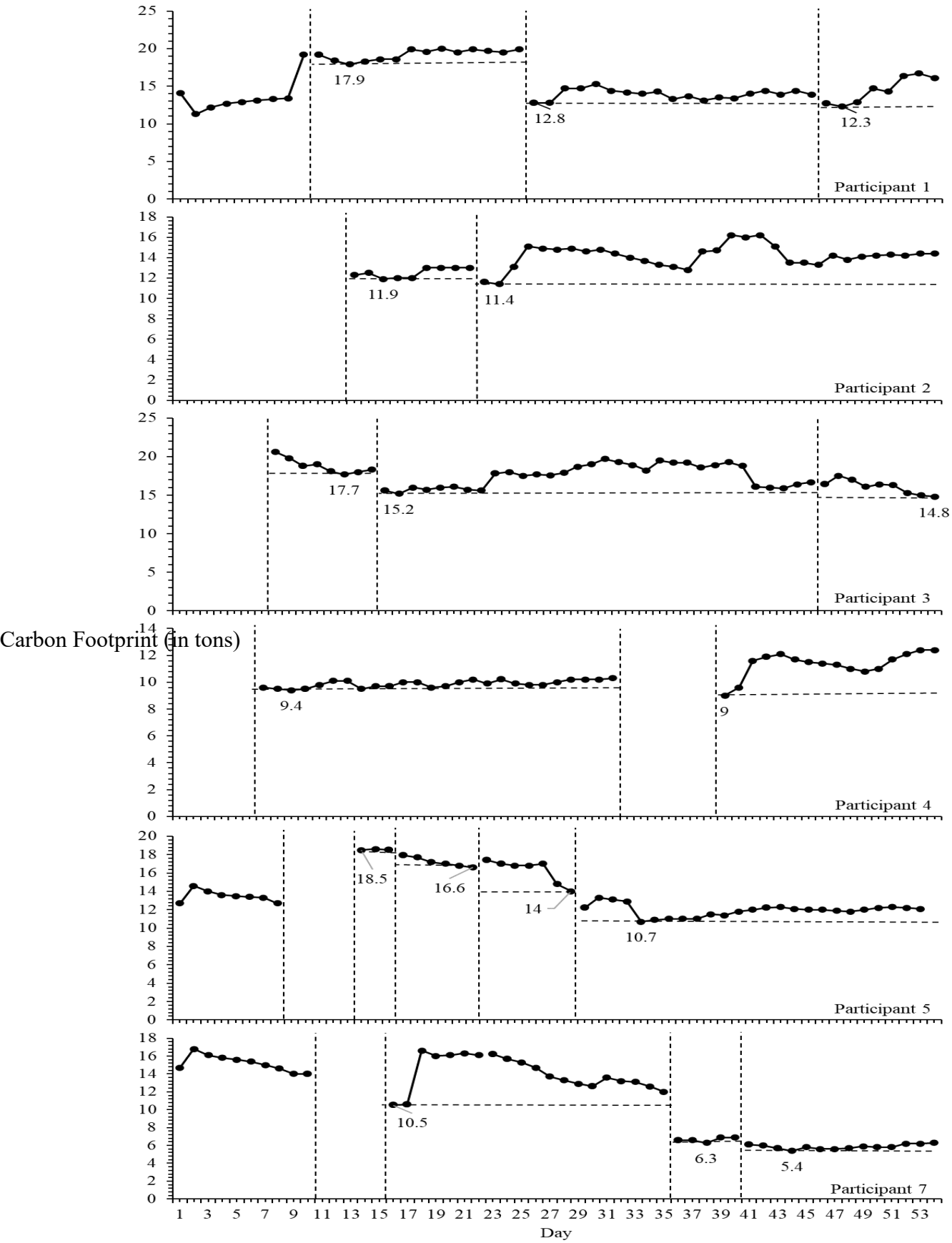


Figure 13. Another depiction of the frequency of days each participant was able to remain below their predetermined thresholds.

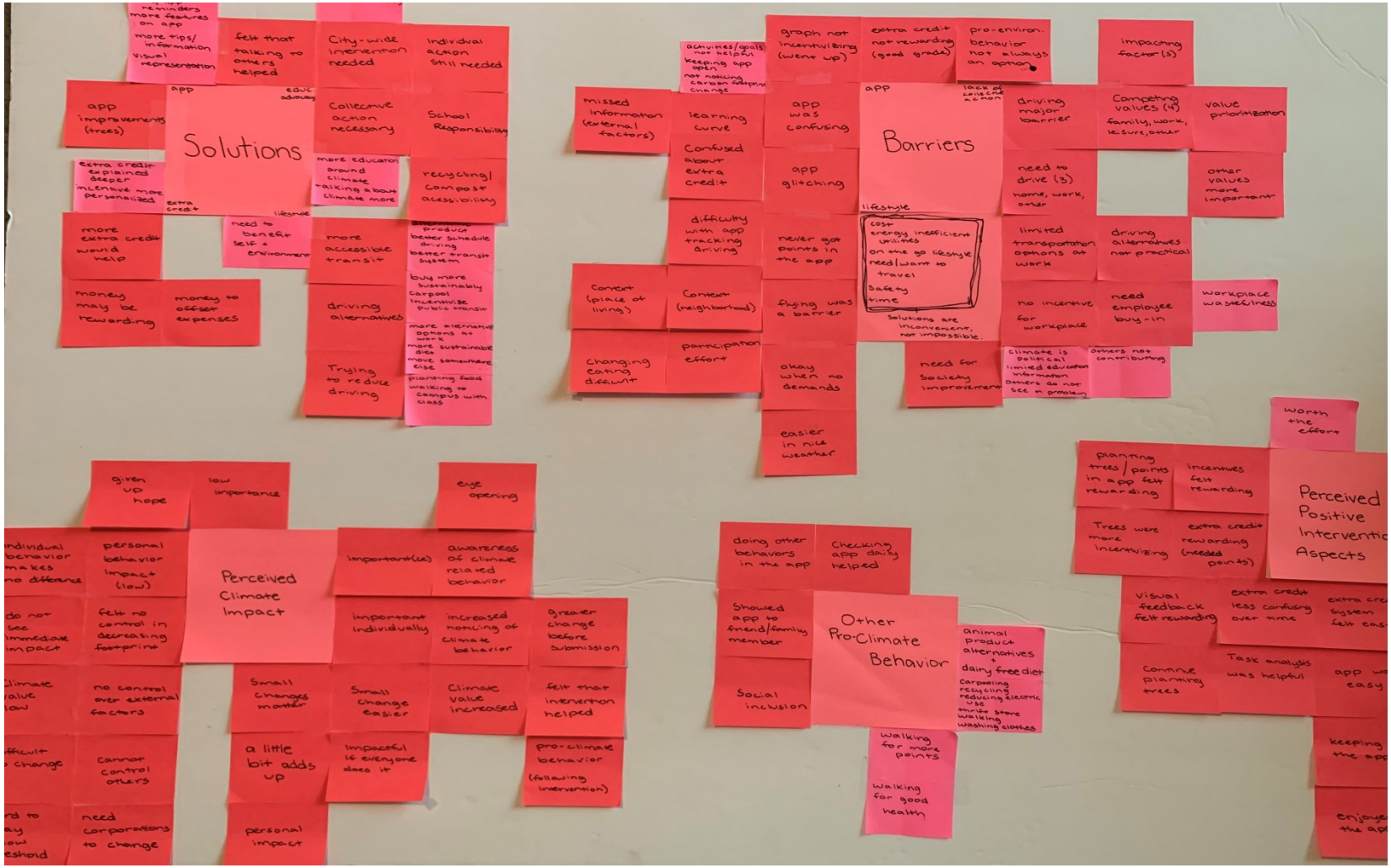


Figure 14. An example of the grouping of codes using the affinity diagram process.

APPENDICES

Appendix A. Human Subjects IRB Approval

Date: 5-28-2022

IRB #: IRB-FY2022-394
Title: Evaluating the Effects of Incentivization and Self-Monitoring on Climate Related Behavior
Creation Date: 1-5-2022
End Date:
Status: Approved
Principal Investigator: Jordan Belisle
Review Board: MSU
Sponsor:

Study History

Submission Type	Review Type	Decision
Initial	Expedited	Approved

Key Study Contacts

Member	Lauren Hutchison	Role	Co-Principal Investigator	Contact hutchison4628@missouristate.edu
Member	Shelby Blecha	Role	Co-Principal Investigator	Contact slb816@live.missouristate.edu
Member	Claire Zuch	Role	Co-Principal Investigator	Contact claire12@live.missouristate.edu
Member	Jordan Belisle	Role	Principal Investigator	Contact jbelisle@missouristate.edu
Member	Meredith Matthews	Role	Primary Contact	Contact meredith567@live.missouristate.edu
Member	Meredith Matthews	Role	Investigator	Contact meredith567@live.missouristate.edu
Member	Lauren Hutchison	Role	Investigator	Contact hutchison4628@missouristate.edu

Appendix B. EARTH-Beta Version Questionnaire (Matthews et al., 2021)

EARTH-Beta Version Questionnaire
At least 25% of house lights are energy efficient (e.g., LED, smart)
25% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)
At least 25% of purchased clothing is responsible, second hand, or is worn more than 30 times
Water is turned off between dishes when washing dishes
Appeals to family to increase sustainability are made at least once per year
Water is mostly consumed from a reusable water bottle
All daily notes are recorded without paper
Appeals to friends to increase sustainability are made at least once per year
50% of household cleaners are natural (i.e., do not contain unrecognizable chemicals)
50% of hygiene and/or makeup products are natural (i.e., do not contain unrecognizable chemicals)
At least 25% of new household purchases are recyclable, local, or ecofriendly
Water is always consumed from a reusable water bottle
At least 50% of purchased clothing is responsible, second hand, or is worn more than 30 times
Reusable containers are used when purchasing bulk produce
All household cleaners are natural (i.e., do not contain unrecognizable chemicals)
All hygiene and/or makeup products are natural (i.e., do not contain unrecognizable chemicals)
Use only natural light in the middle of the day
At least 50% of new household purchases are recyclable, local, or ecofriendly
All purchased clothing is responsible, second hand, or is worn more than 30 times
Food products in single use plastic containers are avoided

Appendix C. Demographic Questionnaire.

1. What gender do you identify as?
   a) _____
   b) Prefer not to say

2. How old are you?
   a) _____
   b) Prefer not to say

3. What is your ethnicity?
   a) _____
   b) Prefer not to say

4. What year of college are you in?
   a) _____
   b) Prefer not to say

5. What is your academic major or graduate program?
   a) _____
   b) Prefer not to say

Appendix D. Qualitative Interview Guide.

1. The purpose of the incentive program was to reduce carbon emission behaviors. In most cases, the program was not effective in achieving this goal. How do you perceive the importance of reducing high emission behaviors?
    a. How does achieving this value of reducing personal carbon emission compete with other values or important things in your life?
    b. What are your perceptions about the effect reducing your personal emissions will have on earth's climate?

2. When you reflect on the incentive program for reducing carbon emissions that you took part in, what were challenges or life barriers that made it difficult to stay below the carbon threshold?
    a. How easy are these barriers to change in your current circumstance?
    b. If you had more time like 6 to 12 months, are there any larger changes in your life that you might consider making that could help to resolve some of these barriers?

3. The program that you took part in contained two incentives that included extra credit points in class and the opportunity to plant trees. How did you find those incentives influenced your carbon emission behaviors such as driving, carpooling, walking, or biking?
    a. Are there other behaviors that you found yourself engaging more in to reduce your emissions on the application?
    b. Was the payout in extra credit and trees worth the extra effort to change your emission behavior?
    c. What *would* be enough of an incentive?

4. When reflecting on the incentive program, what factors might have made it more likely for you to engage in the program and to reduce your carbon emission behaviors?
    a. How would you describe your experience with using the application?
    b. How would you describe your experience with submitting results to obtain the extra credit incentive?

5. If incentive programs and apps like those used in this study are not effective alone, can you think of any changes in your school and/or workplace that could be effective in reducing your carbon emission behaviors?
    a. Why is it likely or unlikely that a school and/or workplace would make these changes?