

**Exploring the underlying processes and the long term effects
of Choice Architecture**

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ABSTRACT

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As the application for choice architecture grow, our goal is to better understand both the short and long term effects of our interventions. Many of the world's most pressing and complicated problems require many actions, instead of a single action. Choice architecture has been shown to be effective on one-and-done problems, but what about the more complicated problems? Can the tool we choose to influence behavior have a positive or negative effect on the likelihood of taking up a second or possibly third behavior? In Chapter 1, we explore the mechanism of risky choice framing, isolating the effect of attraction and repulsion on the number of, and the valence of, thoughts supporting either the risky or riskless outcomes. In Chapter 2, we show behavioral spillover in a lab settings, showing the effects of default setting on not only the initial behavior, but also subsequent behaviors. In Chapter 3, we take choice architecture and explore the effects of different messaging on both short and long term behavioral change.

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Number three!³

¹ First African American male to be awarded a PhD from Columbia University, Department of Psychology.

² The second.

³ I am the third.

Dedication

I dedicate this to my daughter, JMC, and my wife, Danielle. JMC, long before you were born, before mommy and I were married, I wanted to show this to you. It is not about the document, for it is not my magnum opus, and it is not about being called doctor. It is about the struggle, the many failures, and the years of tears and anguish— every time I didn't know how I was going to make it, how I was going to be the best version of myself, or how I was going to make a better world for you. I needed to do all of this so that one day, when you feel like you have hit the wall, when it seems like everyone doubts your ability, your strength, and your personhood, you can look to your father and know that he made it through, and with his support, you will too.

Danielle, your support has always been the most crucial part of this journey. Without it, I do not know where I would be right now. Together, we can and will do it all.

I. Motivation and Overarching Questions

Psychologists are more often being called upon to “leave the lab” and help address large scale societal issues, such as the impending financial crisis that will result from individuals’ lack of retirement savings; anthropogenic climate change left unchecked due to the international community’s inability to address greenhouse gas emissions; or the growing, costly and deadly obesity epidemic occurring across the U.S. and other developed countries. The turn toward psychologists, by policymakers, advocates, and communicators, for answers to these persistent problems has come from a recognition that many, if not most, of the major societal issues we face today are, at their core, *problems of human behavior*. Who better to ask than psychologists as to how we can encourage people to change their behavior to benefit themselves and society?

As interest in evidence-based behavior change techniques has grown, one method has received a lot of attention, namely choice architecture. Choice architecture is referred to in the literature and industry by a variety of names, including “nudges,” “behavioral economics,” and “decision architecture,” but I will use the more inclusive and descriptive term “choice architecture”. National governments have “nudge groups” (e.g., Social and Behavioral Science Team, Behavioural Insights Team) playing key roles in shaping policy. Companies have realized the use of choice architecture can shift employee and customer behavior just as well as monetary incentives, but often at a lower (or no) cost. Public health officials are discovering new ways to improve medication compliance and uptake of health promoting behaviors without costly direct monitoring (Social and Behavioral Sciences Team, 2016; The Behavioural Insights Team, 2016).

It all seems so simple: Change a default here, limit the set of alternatives there, add a pinch of framing, and the new, optimal behavior emerges, free of overly paternalistic intervention. Organ donation, a poster child of choice architecture proponents, is a prime

example of how changing the framing of a desired behavior from opt-in to opt-out can increase its adoption. In this case, having organ donation on driver's license applications as the opt-out default option (i.e., the "yes" for organ donation is preselected) greatly increases the number of potential donors versus an opt-in default option (Johnson & Goldstein, 2003). While this, "one-and-done" problem is largely addressed by changing the default for enrollment, addressing many of the current environmental, financial, and health issues we face will require multiple actions and changes in behavior over a prolonged period of time. Further, these changes may involve both individual and collective action. Problems such as excessive energy consumption or chronic disease control require people to engage in multiple, additive behaviors that address the same problem. Switching to energy efficient light bulbs is not enough to lower a large carbon footprint and yield impactful environmental change; getting vaccinated against the flu is not sufficient to achieve overall good health; being automatically enrolled into a retirement savings plan by an employer is not enough to ensure financial security in retirement, although each of these actions are important steps towards achieving the end goal.

The overarching motivation for my research is twofold. The first is to better understand the process mechanism of the "risky choice framing" choice architecture tool. Risky choice framing is widely used, and is functionally described by prospect theory (PT), but PT does not explain why or how the specific shape of the value function, concave for gains and convex for losses, or the certainty effect come about. This has been done for other interventions (e.g., defaults (Dinner, Johnson, Goldstein, & Liu, 2011)), but not for framing. The second motivation for this research is to understand whether and how choice architecture can be used in ways that encourage not just a desired first behavior, but also the *next* behavior (and the one after that). I

will ask the related question of whether some choice architecture interventions may work well for the first behavior, but may in fact discourage subsequent additional action.

II. Theoretical background and current state of knowledge

For my dissertation, I will expand the knowledge of the underlying processes of **risky choice framing** as well as explore the longer-term consequences of three core choice architecture tools: **defaults, social norms and negative affect**.

a. Process underlying Risky Choice Framing

Many decisions involve choosing between a certain option and a risky option. For example, one decision faced by millions of Americans every year is “Should I get the flu vaccine?” While there are many barriers to getting the flu vaccine, the main barrier for many is the perceived certainty of feeling ill while their immune system initially reacts to the flu shot. This certainty of a negative outcome leads people to take their chances on the risky choice option of not getting the flu shot and possibly getting the flu. At a societal level, unwillingness to invest in climate change mitigation indicates that for this decision, also typically presented in a loss frame, we are also risk-seeking (i.e., willing to take our chances at serious consequences down the road to avoid the certainty of a relatively small economic sacrifice right now). At the same time, for many gain-framed decisions, we decide to take the certain outcome, choosing in a risk-averse fashion. This is an example of risky choice framing.

Tversky and Kahneman (1986) explained this phenomenon with prospect theory (PT), which posits that the values of outcomes of choice options are encoded relative to a reference point, with a concave value function for gains and a convex value function for losses. They demonstrated this effect with the Asian disease (AD) problem, where participants chose between two public health programs for the treatment of a disease, one a certain option and the other a risky option. When framed as gains – lives saved – participants chose the certain option more often than when the outcomes were framed as losses – lives lost. This effect has been reproduced across a series of studies and over various contexts with similar results – risk seeking in the

domain of losses and risk averse in the domain of gains (Druckman, 2001; Kühberger, 1998; Kühberger, 1997).

Other theories have also been proposed to account for this effect. Kühberger and Tanner (2010) applied fuzzy trace theory (Brainerd & Reyna, 1990) and hypothesized that people encode the numbers in the AD paradigm in more general, fuzzy terms. Saving “some people” for certain feels better than the chance that not all people will be saved, but having “some people” die for certain sounds worse than the possibility of not all people dying, leading to risk aversion in the gain frame and risk seeking in the loss frame (Reyna & Brainerd, 1991).

The role of affect has also been considered a possible driver of risky choice framing. Although anecdotal, loss aversion is commonly described as losses hurting more than gains are gratifying. This pain can only be emotional in nature. It has been speculated that fear of this emotional pain could be the driver behind loss aversion (Camerer, 2005). Affect has also been shown to moderate risky choice framing. Positive emotions like enthusiasm and joy have been shown to lead to an increase in risk-seeking behavior (Druckman & McDermott, 2008). Certain negative emotions, including sadness, have been shown to lead to more thoughtful decision making (Kahneman, 2011), but also increasing impatience (Lerner, Li, & Weber, 2013). Other negative emotions, including distress, have been shown to increase the impact of frame in risky choice paradigm (Druckman & McDermott, 2008). While affect has been shown to influence risky decision making, current theory does not provide a cognitive process explanation of how these differences in risky decision making arise.

Whereas eye- or mouse-movement process tracing allows for the examination of option value construction processes during external evidence examination (Willemsen, Böckenholt, & Johnson, 2011), Query Theory (QT) (Johnson, Häubl, and Keinan, 2007) provides tools to

understand option value construction as the result of internal information search processes during decision making. Decision makers construct their preferences (Lichtenstein & Slovic, 2006) by recruiting evidence for choosing one or another option. The queries for such evidence are produced serially (Johnson, Häubl, & Keinan, 2007): The order in which such serial queries are issued would not matter, if the evidence generated by each query solely depended on prior experiences or knowledge about the two options. However, due to output interference – where the retrieval of initial thought items reduces the accessibility of later items (Smith, 1971) – the choice option queried first is advantaged, resulting in a richer set of arguments that make it more likely to be chosen. Numerous studies have applied QT and its pre-choice thought listing procedure (where people are asked to list the thoughts that go through their mind as they contemplate an indicated choice) to account for a wide range of observed choice inconsistencies, including the effect of attribute framing (Hardisty, Johnson, & Weber, 2010), the endowment effect (Johnson et al., 2007), and differences in intertemporal choice as the result of changing the choice default (delaying immediate consumption vs. accelerating future consumption) (Weber et al., 2007).

In all of these applications, normatively irrelevant features of the choice environment (which option was the choice default or the label of a choice option) were shown to influence relative attention to the two choice alternatives, resulting in support for different choice options being queried first, which in turn resulted in a different balance of evidence supporting the two choice options, which in turn mediated observed differences in choice. The choice option queried first can be driven by natural defaults in the situations (e.g., possession of the mug in the endowment effect) or by the emotional attraction of the choice (e.g., taxes in the attribution framing effect). Furthermore, these studies provided causal evidence for the role of order of

(typically implicit and automatically) generated queries by asking respondents explicitly to generate support for one and then the other choice option either in the “natural” order observed in these situations (e.g., reasons to keep the mug in the endowment effect study, support for the smaller sooner choice in intertemporal choice study) or in the opposite “unnatural” order (e.g., reasons for selling the mug, support for the later larger choice). All of the studies showed that reversing the natural query order attenuates or removes the effect of default or frame on choice.

b. Choice Architecture and Spillover

Choice architecture refers to the organization and influence of the context in which a decision is to be made, including the response mode (e.g., willingness to pay, choice, ranking); the number of attributes, alternatives, and outcomes; the framing of outcomes; and the correlation between options’ attributes (Camilleri & Larrick, 2014; Johnson et al., 2012; Thaler & Sunstein, 2008). The concept of nudging is the purposeful design of the choice architecture to predictably alter behavior without removing freedom of choice.

In the present research, we begin the process of exploring possible downstream consequences of three widely used choice architecture tools: defaults, social norms, and negative affect. A *default* is set when a particular choice option is enacted if the decision maker does not actively decide to change away from it (Brown and Krishna, 2004). The impact of default framing has been shown in many domains including health (Halpern, Ubel, & Asch, 2007), finance (Madrian & Shea, 2001), and the environment (Kunreuther & Weber, 2014). Defaults are often extremely effective because they address a key choice hurdle, decision inertia or status quo bias, turning the hurdle into a positive force in some form of psychological jiu-jitsu (Weber, & Johnson, 2012). Decision inertia refers to the fact that selecting or rejecting an option requires effort. If a decision maker is unwilling to exert that effort, the choice that requires the least effort

(e.g., the one that is automatically made) will be selected (Johnson et al., 2012; Sunstein, 2013; Thaler & Sunstein, 2008).

Setting beneficial defaults is effective because doing so addresses a key barrier to decision-making—decision inertia (i.e., the fact that selecting or rejecting an option requires effort) or status quo bias (i.e., the tendency to stick to a current course of action rather than shift away)—turning this psychological hurdle into a force for better decision-making (Weber, & Johnson, 2012).

A second widely used tool is the strategic provision of *social norms* information leverages an individual's motivation to develop and maintain social relationships to guide choice (Cialdini & Goldstein, 2004). By emphasizing what most people do (i.e., descriptive norms) and/or what most people believe is the correct course of action (i.e., injunctive norms), providing social norms information has repeatedly been shown to influence behavior across numerous domains (Lapinski & Rimal, 2005; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Thaler & Sunstein, 2008). Indeed, a number of businesses and organizations have successfully developed large-scale behavior change efforts that use social norms information (e.g., OPOWER) (Allcott & Rogers, 2014; Frey & Rogers, 2014).

In addition to setting positive defaults and providing social norms information, many behavior change interventions have relied on a third choice architecture tool: inducing negative affective states in decision-makers. Decision can be viewed as the way we attempt to avoid negative feelings (e.g., guilt) and approach positive feelings (e.g., happiness) (Lerner et al., 2015). Negative affect based decision making uses this approach/avoidance reaction to emphasize the potential affective outcomes and guide choice. Risk perception, and attention and processing have been shown to differ based on affective state (Lerner & Keltner, 2001; Schwarz

& Norbert, 2000; Slovic, Peters, Finucane, & MacGregor, 2005). Negative affect interventions have been used effectively to reduce smoking uptake among teenagers (Witte & Allen, 2000).

Although all three of these tools have been used to successfully change targeted behaviors, each runs the risk of producing unanticipated and undesirable downstream effects on subsequent action. This is because the mechanisms by which they are believed to work (e.g., bypassing information processing, emotion regulation, reputation maintenance) are effective for inducing immediate behavior change, but may make subsequent goal-consistent behaviors *less* likely, an effect referred to as *negative behavioral spillover* (Truelove et al., 2014). There are a number of psychological mechanisms that have been shown or theorized to lead to negative behavioral spillover, including many of these same mechanisms (e.g., negative affect state relief, moral licensing, and economic rebound effects).

Negative behavioral spillover can take several forms, one of which is the *single action bias* (Weber, 1997), a situation in which decision makers will take one action to reduce a risk, but in doing so become less likely to take additional steps that would provide incremental protection or reduced risk (due to a perceived sense of having sufficiently reduced the risk). Decision makers in this scenario view the risk as an “emotional red flag” that needs to be addressed; unfortunately, once the risk has been addressed via the initial action, the emotional flag goes down and there is no longer motivation to put forth further effort to address the remaining risk. The farmers in Weber’s (1997) initial study not only failed to take additional risk reduction actions on their farms, but were also less likely to support effective policies after taking an initial (insufficient) action to reduce the risk of climate change. In a related vein, Kristofferson, White, and Peloza (2014) define *slacktivism* as the willingness to perform a relatively costless, public token display of support (e.g., a “like” on Facebook), but lack of

motivation to devote significant effort to enact meaningful change. While these public token actions can lead to greater awareness of an issue, they often have limited long-term value, because the initial costless action leads to negative behavioral spillover, as individuals lose motivation to take further action.

Another demonstration of negative behavioral spillover comes from the literature on *moral licensing*, a phenomenon in which past (subjectively) morally right behaviors give people “license” to commit immoral actions that they otherwise would not commit (Kouchaki, 2011; Merritt, Effron, & Monin, 2010). This regulation and balancing of moral behavior is directed, at least in part, by an individual’s self-image. As individuals perform actions that increase their sense of being a moral person, they become less likely to partake in additional moral behavior, but if they are feeling morally low, they will seek out morality increasing behavior to increase their moral self-image (Zhong, Liljenquist, & Cain, 2009). A study by Monin and Miller (2001) showed that participants who previously demonstrated their lack of prejudice, namely by choosing an African-American candidate for a job, were more likely to report that another, unrelated job would be best filled by a white person.

A third and widely recognized instantiation of negative spillover is the *rebound effect* (Ehrhardt-Martinez & Laitner, 2010; Sorrell 2007). Rebound effects refer to situations in which potential gains (e.g., reduction in gas consumption due to purchase of hybrid vehicle) are not fully realized (and in some cases completely wiped out) due to changes in cost incentives (often because of increasing efficiency), which lead to greater resource consumption than would be expected given those gains. For example, people tend to drive more miles after purchasing an efficient vehicle in part because the use cost is lower (Hertwich, 2008).

While other mechanisms behind negative behavioral spillover may still need to be uncovered, the effect of negative affect on spillover is apparent. Decision makers who encounter negative emotional pleas or situations will focus their energy on relieving those negative feelings (e.g., farmers dealing with the prospect of climate change impacts on their farms and their income) and have little reason to engage in subsequent goal-concordant behaviors once the negative affect “flag” has come down. Other decision makers may capitalize on reduced costs due to technological innovation in energy efficiency by increased energy consumption in the same domain (driving further in low consumption vehicles) or other domains (spending the money saved by driving a low consumption vehicle on vacation air travel), because they view these decisions as financial issues.

Positive behavioral spillover refers to situations in which performance of an initial behavior promotes congruent subsequent actions. An individual who decides to increase the temperature on their home air conditioner displays positive behavioral spillover when they subsequently decide to ride a bicycle to work (another pro-environmental behavior). One of the earliest examinations of positive behavioral spillover was Freedman and Fraser's (1966) work on the compliance technique they termed Foot-in-the-Door (FITD). Foot-in-the-Door was successful in getting individuals to agree to larger, more complicated demand after they had agreed to comply with a small demand. In the classic FITD paradigm, a researcher or practitioner asks an individual to do something very low cost (e.g., put a small placard supporting a cause in their front window); later, the individual is then asked to do a more costly, public action supporting the same cause (e.g., place a large sign on their front yard). Since the early work on FITD, numerous theories have been put forth to explain the effect (primarily cognitive dissonance and self-perception theory).

Classic work on behavioral consistency (Festinger, 1962) identifies an important mechanism in motivating positive behavioral spillover. When actions are inconsistent with beliefs, individuals might experience cognitive dissonance (Festinger, 1962), a negative state. In order to avoid that state and to remain consistent, individuals reassess their beliefs to coincide with their behavior, removing the dissonance and changing parts of their initial beliefs. This theory highlights the ability of the initial behavior to influence beliefs and thus increase the likelihood of the spillover behavior.

Following up on early work on compliance and attitude change, Bem (1972) hypothesized that performing a specific behavior activates the internal values associated with that behavior and makes them more salient, leading to a greater likelihood of performing a second behavior that shares the same values or ultimate goals. Bem's self-perception theory suggests that spillover might be contingent on the initial action both promoting a shared value or goal with subsequent choice opportunities as well as being clearly linked to those later decisions (Thøgersen, 2004); that is, individuals need to be aware of the connection between the initial and the subsequent behavior for spillover to occur. In addition to bringing the values to the forefront, individuals want to act in a consistent manner. The initial action also induces the decision maker to seek out and perform other behaviors that further support their identity (Van der Werff, Steg, & Keizer, 2013).

While slacktivism may decrease positive behavioral spillover, Kristofferson, White, and Peloza (2014) showed that the act of doing the small behavior in private (rather than publicly) may increase performance of subsequent meaningful support behaviors, presumably because the decision maker infers that there is no other attribution for it than internal beliefs in its value.

This difference in results suggests that the internal attribution of *why* the initial action was taken matters.

Weber (1998) states that the mode by which a decision is made, role and ruled-based, calculation-based, or affect-based decision modes, often determines the outcome. Truelove et al. (2014) extended the decision mode model and put forward a framework to better understand the connection between the decision mode by which an individual chooses to complete the first behavior and the likelihood of the same individual completing a second behavior.

The way an initial behavior does or does not connect with the decision maker's role and identity has serious consequences in regards to future behavior (i.e., positive or negative spillover).

Whether it is that each subsequent behavior reinforces lightly held values until they become part of the decision maker's identity, or that temporary conflict forces to the decision maker to choose consistently, the connection to a decision makers identity or social role is key to influencing positive behavioral spillover.

Given that the internal attribution of *why* an initial action was chosen matters, it is important to examine how choice architecture interventions affect not just the decision they are designed to influence, but also subsequent decisions. If awareness of the influence of the choice architecture format or intervention results in an external attribution of the action taken (thus reducing the likelihood of an internal attribution and thus strengthening of consistent values, beliefs, and self-identity), then the positive effect of the choice architecture intervention on the immediate decision may well be offset by negative effects on subsequent related decisions.

III. Research Chapters

Chapter 1: Risky Choice Framing, a Process Model

In this series of studies, we extend previous QT research to understand the concrete psychological processes (related to attention and the retrieval of internal evidence) that bring about the well-established differences in risky decision making as a function of gain- vs. loss-framing of outcomes. In our studies, similar to Hardisty, Johnson and Weber (2010), attention is driven not by a choice default, but by the attractiveness of the choice outcome. Here, attractiveness is determined by the frame of the certain option. Kahneman and Tversky (1979) demonstrated that people give greater weight to certain outcomes when comparing them to probabilistic outcomes. In Study 1, we hypothesize that this greater weight leads to a strong attraction to the certain gain outcome and also a strong repulsion to the certain loss outcome, which determines which options receives the initial attention. Further we expect that this attention will drive the query order. In the gain frame, respondents will query arguments for the certain option before arguments for the risky option, with the opposite in the loss frame. We expect that query order and resulting balance of evidence (structure and resulting number of thoughts supporting each choice option) will mediate observed effects of the frame on choice. In Study 2, we will show the effect of query order and structure of thoughts on outcomes, we have individuals consider the benefits of the unattractive option first which we predict will attenuate the framing effect.

Study 1a - Replicate Asian disease paradigm with process measure

In Study 1a we replicate the classic risky choice problem and investigate how the attraction caused by the gain and loss frames affects the construction of preferences. As in previous QT studies, we use a concurrent thought listing to investigate how preferences are constructed. The thought listing have participants type out their thoughts as they make a choice.

We expect differences in the structure of thoughts between outcomes framed as gains and those framed as losses. Specifically, we expect that in the gain frame participants will query arguments for the certain option first or earlier than participants in the loss frame, and will therefore generate more such arguments.

Method

Participants

We recruited 181 participants (94 female), ranging in age from 19 to 65 with a mean of 33.7, $SD = 10.81$, with 143 reporting an education level of some college or higher, from Amazon Mechanical Turk, an online labor pool. Participants were given \$1 for completing this study. To ensure participants were reading the instructions and prompts carefully we included an attention check question. Participants who failed the attention check question were not included in the final analysis. For this study the attention check question removed 9 participants.

Procedure

To familiarize participants with the aspect listing interface, participants listed thoughts about purchasing a vehicle (Hardisty et al., 2010; Johnson et al., 2007; Weber et al., 2007); Johnson & Weber 2010). Next participants were shown either a gain or loss frame of a risky choice scenario. Initially, we replicated four scenarios using risky choice framing; Asian disease, explained below, a drought, an investment (Peters & Levin, 2008) and employment choices in a factory (Schneider, 1992). Each scenario replicated with the exception of the investment scenario. Given the general familiarity of the AD problem, the ease to manipulate affect and the successful replication, we decided to continue using only the AD problem. The exact wording of our amended version of the classic AD gain and loss frames are as follows.

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 720 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows (without the “Certain Option” and “Risky Option” labels):

Gain Frame:

If Program A is adopted, 240 people will be saved. (Certain Option)

If Program B is adopted, there is 1/3 probability that 720 people will be saved, and 2/3 probability that no people will be saved. (Risky Option)

Loss Frame:

If Program A is adopted 480 people will die. (Certain Option)

If Program B is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 720 people will die. (Risky Option)

After participants saw the problem, they were instructed "Before you indicate your preference for these programs, please tell us everything you are thinking of as you consider this decision between Program A and Program B. We would like you to list any thoughts, both positive and negative, that you might have about this decision. We will ask you to enter your thoughts one at a time." On average, participants listed 3.96 thoughts ($SD = 2.43$). After listing all of their thoughts, participants were asked to choose one of the two programs, Program A (the certain option) or Program B (the risky option). Next participants were shown their thoughts, one at a time, and asked to rate them as being from one of five categories: "An advantage of Program

A", "A disadvantage of Program A", "An advantage of program B", "A disadvantage of Program B", and "neither." Finally, participants provided demographic information.

As predicted by Prospect Theory, the proportion of participants who chose the certain option differed by frame. In the loss frame that proportion was .55 with a 95% Confidence Interval (CI) of [.44, .65]; whereas in the gain frame, it was .71 with a 95% CI of [.59, .80].

The difference in proportions between the gain and loss frames was .16 with a 95% CI of [.004, .31]. This was confirmed by a chi-square test of difference in proportions, ($X^2(1, N = 171) = 3.92, p = .048$).

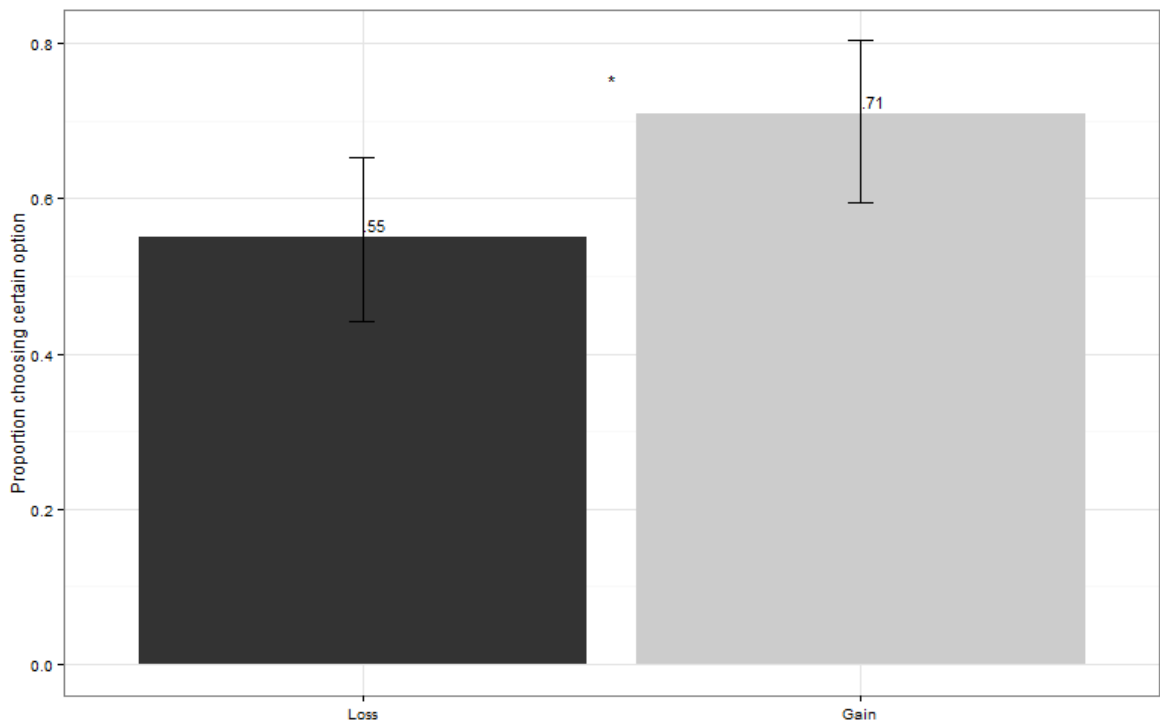


Figure 1. Proportion choosing the certain option. Note: Although the CI's of the gain and loss frames overlap, it is important to remember that: "CIs do not allow one to make probability statements about parameters or hypothesis" (Hoekstra, Morey, Rouder, & Wagenmakers, 2014).

As in prior QT studies, aspect ratings were combined into support for one or the other choice option. "An advantage of Program A", and "A disadvantage of Program B" both provide

support for choosing the certain option A. Similarly, "An advantage of Program B", and "A disadvantage of Program A" both provide support for choosing the risky option B. Twelve individuals entered aspects that were neither in support of the certain or the risky option and were not used in the below analysis.

Two descriptive statistics characterize the structure of thoughts, standardized median rank difference (SMRD) and balance of thoughts (Johnson, Häubl, & Keinan, 2007; Weber et al., 2007; Hardisty, Johnson, & Weber, 2010). Standardized median rank difference takes the difference between the median rank of all evidence supporting the certain option and the median rank of all evidence supporting the risky option. If thoughts supporting the two options are equally interspersed, the two median ranks will be very similar and the difference close to zero. If all thoughts supporting the certain option are generated first, followed by all thoughts supporting the risky option, the median rank of thought supporting the certain option would be high, and the median rank of thoughts supporting the risky option would be low, making for a positive difference. After standardization using the formula $2(MR_r - MR_c)/n$, where MR_c is the mean rank of thoughts supporting the certain option and MR_r is the mean rank of thought supporting the risky option, the SMRD can range from -1 (pro-certain thoughts listed after all pro-risky thoughts) to +1 (pro-certain thoughts listed before all pro-risky thoughts). Balance of thoughts is the difference score between the number of thoughts supporting the certain option and those supporting the risky option.

Figure 2 shows the mean SMRD for both frames. The SMRD was higher the gain frame ($M = .43$, 95% CI = [.23, .61]) than in the loss frame ($M = .15$, 95% CI = [-.04, .34]). The interval for the difference of SMRDs between the gain and loss frames did not include zero ($M = .28$, 95% CI = [.01, .55]). Further, an independent-samples t-test was conducted to compare

SMRD in Loss and in Gain conditions was significant; $t(156.33)=2.05$, $p = .04$. According to convention, this was a medium effect of frame on SMRD, Cohen's d effect size ($d = .32$).

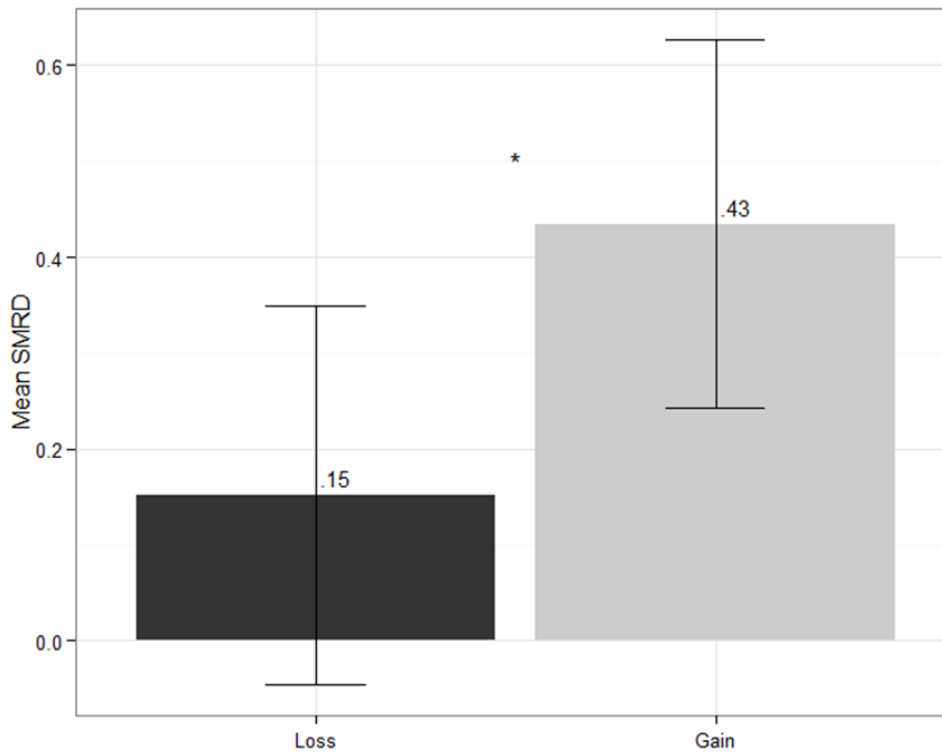


Figure 2. The mean SMRD for both frames using bootstrapping with 10,000 replications to calculate confidence intervals

As QT would predict, since number of thoughts supporting a given choice option is determined by query order and differences in SMRD should result in differences in number of thoughts supporting the two choice options, as shown in Figure 3, the mean balance of thoughts (i.e., number of thoughts supporting the certain option minus number of thoughts supporting the risky option) for the loss group was .40 with a 95% CI of [.19, .61]. The mean balance of thoughts for the gain group was 1.29 with a 95% CI of [1.04, 1.55]. The estimated difference in balance of thoughts was .89 with a 95% CI of [.24, 1.54]. Further, an independent-samples t-test was conducted to compare SMRD in Loss and in Gain conditions was significant;

$t(145.21)=2.70, p = .01$. According to convention, this was a medium effect of frame on SMRD, Cohen's d effect size ($d = .43$).

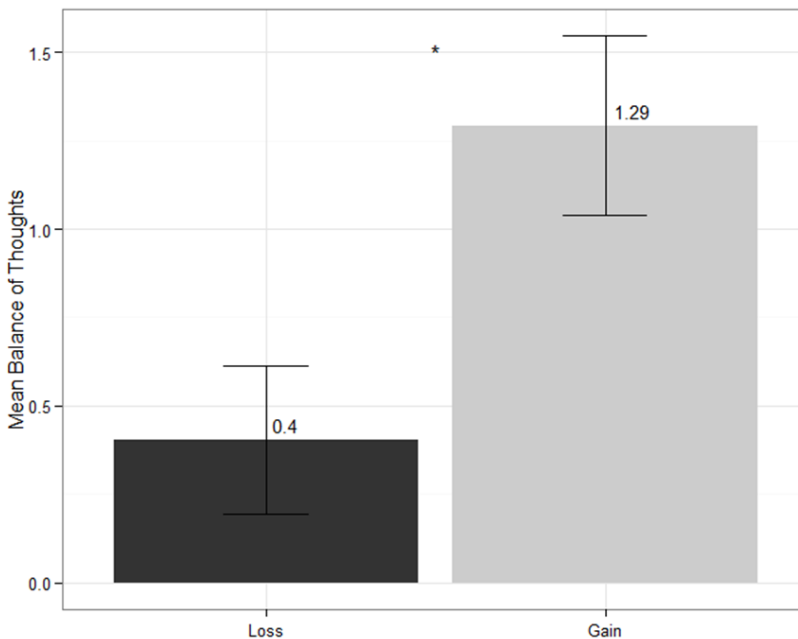


Figure 3. Average Balance of Thoughts for the Asian disease problem

Since SMRD and balance of thoughts are correlated ($r = .59$), before running regressions we created an index of SMRD and balance of thought measures by z-scoring both measures and taking their average. This structure of thought index significantly predicted choice ($\beta = 1.62, SE = .26, p < .001$), while accounting for roughly 33% of variance in choices (Nagelkerke $R^2 = .33$).

Further, we expect the Structure of Thought index to mediate the effect of frame. Because our treatment is binary (gain frame versus loss frame), outcome is binary (choice of Program A or Program B), and mediator is continuous (combination of SMRD and balance of thoughts), the assumptions of standard linear structural equation model approach using the product of coefficients do not hold (Imai, Keele, & Yamamoto, 2010). For these reasons, we used the methodology outlined in Imai, Keele, and Yamamoto (2010). Specifically, we estimated the average causal mediation effect (ACME), average direct effect (ADE) and the total effect, which

is conceptually similar to the indirect effect, the direct effect (c') and the total effect (c) in traditional mediation (Baron & Kenny, 1986).

Our mediation analysis had 1000 bootstrapped samples using the *mediation* package in R (Tingley, Yamamoto, and Hirose 2014; R Core Team 2014). The total effect of frame was positive (.18) with a bootstrapped 95% CI which excludes zero [.03, .34], $p < .05$. The ACME of the combination of SMRD and balance of thoughts was positive (.1) with a bootstrapped 95% CI which excludes zero [.03, .17], $p < .01$. When controlling for the structure of thoughts, the direct effect of frame completely mediated (.08) with a bootstrapped 95% CI which includes zero [-.05, .21], $p > .05$.

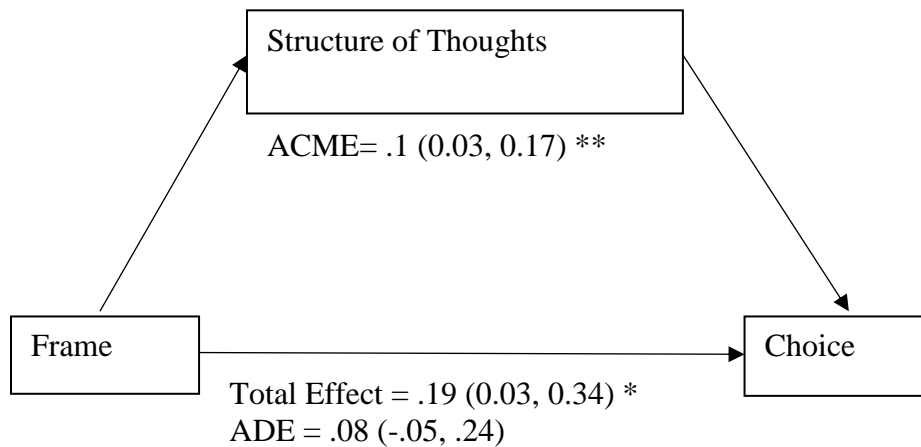


Figure 4. Structure of Thoughts mediate the effect of frame on choice

Further the proportion mediated, the proportion of variance accounted for by the ACME, was positive (.55) and significant ($p = .03$) with a bootstrapped 95% CI which excludes zero [.18, 1.90] (Ditlevsen, Christensen, Lynch, Damsgaard, & Keiding, 2005; L. S. Freedman, Graubard, & Schatzkin, 1992; MacKinnon, Lockwood, Brown, Wang, & Hoffman, 2007). We also performed a sensitivity analysis to which demonstrated that our model was robust to violations of the assumptions underlying ACME (K. Imai & Yamamoto, 2013). Specifically there may be

confounding variables which causally affect both the mediator and outcome variables (Imai, Keele, & Tingley, 2010). Our sensitivity analyses show that the existence of possible confounds is unlikely.

Study 1b - Replicate AD with process measure in high negative affect scenario

In Study 1b, we replicated the QT intervention in a high negative affect scenario. As shown in Figure 5, we increase affect in three ways. First, we change the disease from a non-descript Asian disease, to a medical crisis current at the time of study, namely Ebola. Second, we made the individuals infected by the virus only children. Third, we added photos that accentuated the valence framing of the two frames. In the gain frame, the photo was a child recovering in a hospital bed. In the loss frame, the photo was of a child coffin being lowered into the ground.

Your thoughts

Imagine that The U.S. is preparing for an outbreak of a new strain of the Ebola virus. This strain has a greater effect on children than adults and is expected to kill 720 children. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows:

- Program A:** 240 children will be saved.
- Program B:** A 1/3 probability that all 720 children will be saved and a 2/3 probability that no children will be saved.



[Click here to continue](#)

Your thoughts

Imagine that the U.S. is preparing for an outbreak of a new strain of the Ebola virus. This strain has a greater effect on children than adults and is expected to kill 720 children. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows:

- Program A:** 480 children will die.
- Program B:** A 1/3 probability that no children will die and a 2/3 probability that all 720 children will die.



[Click here to continue](#)

Figure 5. High Affect Risky Choice

Method

Participants

For the replication of Study 1, we recruited 256 (129 female) respondents, ranging between 18 and 72 years old with a mean age of 34.77, SD = 10.86, with 163 reported having an education level of some college or higher, from Amazon Mechanical Turk. An attention check question removed 11 participants.

Materials and Procedure

All procedures are identical to Study 1a.

Results

As shown in Figure 6, we replicated the framing effect of Study 1a (i.e., the proportion of participants who chose the certain option differed by frame). The proportion of participants choosing the certain option was .44 in the loss with a 95% CI of [.36, .54]. In the gain frame, it was .74 with a 95% CI of [.65, .81]. The 95% CI for the difference in proportions between frames was [.17, .42] Further the chi-square test was significant ($X^2(1, N = 245) = 20.36, p < .001$).

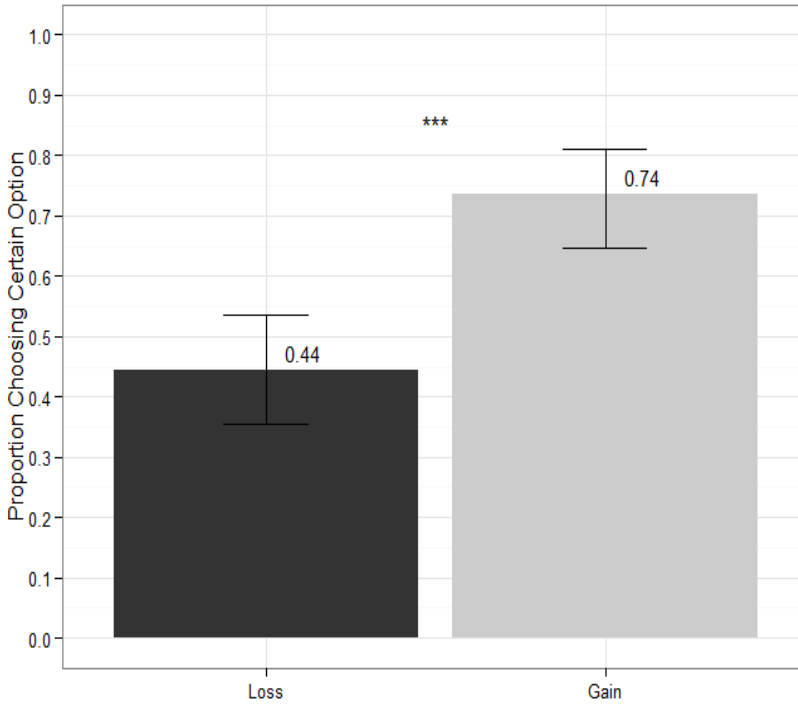


Figure 6. Proportion choosing certain option by frame, high affect

There was a significant effect of frame on SMRD, $t(203.2) = 4.10, p < .001$. The mean SMRD for the loss frame was .01 with a 95% CI of [-.16, .19] and for the gain frame it was .50 with 95% CI of [.35, .65]. The interval for the difference between the gain and loss frames did not include zero [.25, .72]. According to convention, there was a large effect of frame on SMRD, (Cohen's d effect size ($d = .56$)).

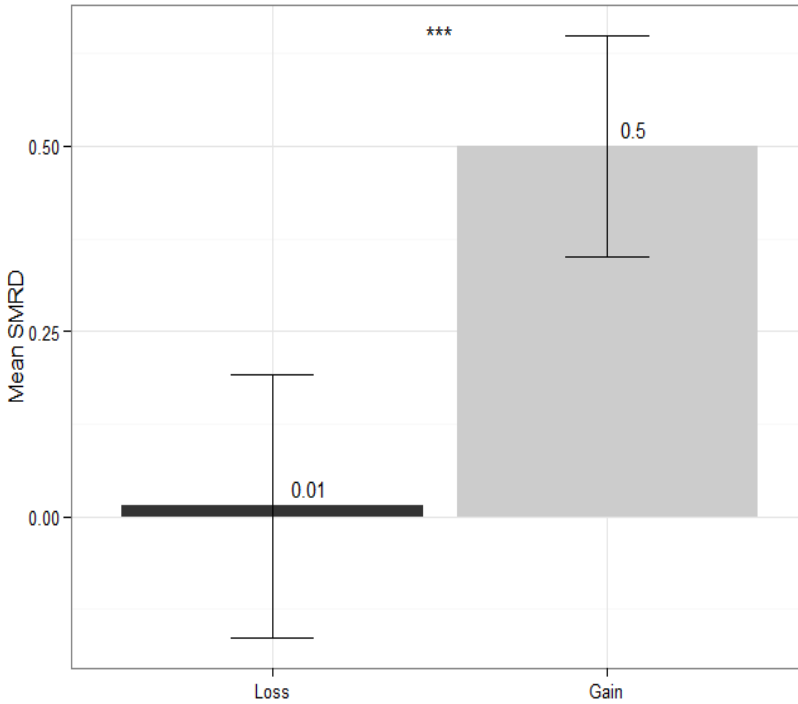


Figure 7. Mean SMRD by frame in high affect scenario

As shown in Figure 8, the mean balance of thoughts (i.e., number of thoughts supporting the certain option minus number of thoughts supporting the risky option) for the loss group was .17 with a 95% CI of [-.27, .61]. The mean balance of thoughts for the gain group was 1.39 with a 95% CI of [.98, 1.81]. The estimated difference in balance of thoughts was 1.22 with a 95% CI of [.61, 1.83]. Further, an independent-samples t-test was conducted to compare SMRD in Loss and in Gain conditions was significant; $t(209.92)=3.94, p = .00$. According to convention, this was a medium effect of frame on SMRD, Cohen's d effect size ($d = .54$).

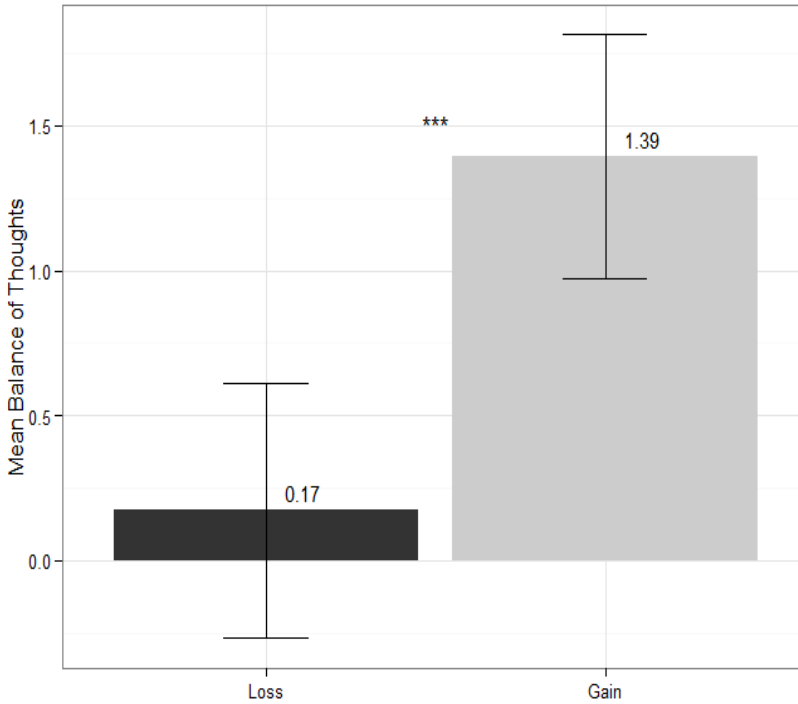


Figure 8. Balance of thought by frame in high affect scenario

The structure of thought index completely mediates the effect of frame on choice. Using the same method of analysis from Study 1a, our analysis had 1000 bootstrapped samples using the mediation package in R. The total effect of frame was .29 with a bootstrapped 95% CI which excludes zero [.15, .42], $p < .01$. The ACME of the structure of thought index was positive .16 with a bootstrapped 95% CI which excludes zero [.09, .24], $p = .01$. When controlling for the effect of the structure of thought index, the direct effect of frame was positive .12 with a bootstrapped 95% CI which includes zero [-.002, .24], $p > .05$. The proportion mediated, the proportion of the total effect accounted by the indirect path, was .57 with a bootstrapped 95% CI which excludes 0 [.34, 1.07] (Ditlevsen et al. 2005; MacKinnon, Lockwood, and Brown 2007; Freedman and Graubard 1992).

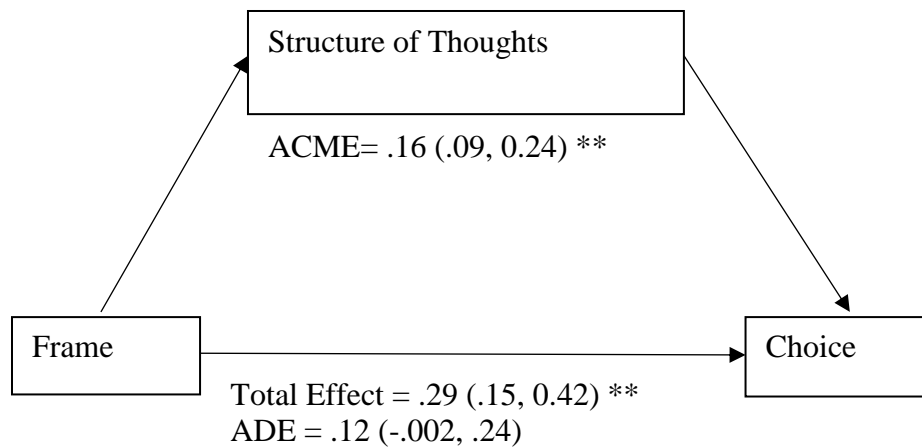


Figure 9. Mediation of the effect of frame on choice by structure of thought in the high affect scenario

As in Study 1a we performed a sensitivity analysis which affirm that the assumptions of our model held.

Study 1a and 1b – Combined Results

As predicted, increasing the emotional intensity of the choice scenarios increased the size of the framing effect and the difference in QT process indicators between the two framing conditions. Combining the data from Study 1a and Study 1b, we examined the thoughts provided by participants for indications of their affective state. We used linguistic inquiry and word count (LIWC), which takes text and outputs the number of function words from different categories (Pennebaker, Boyd, Jordan, & Blackburn, 2015; Pennebaker, Francis, & Booth, 2001). We focused lexicons denoting different emotional states and counted the number of positive emotion words and the number of negative emotion words as well as a summary metric for emotional tone, for which higher numbers indicating more words denoting positive emotional states and lower numbers indicating lower emotional tone, with 50 being the point between positive and negative emotional tone (Pennebaker et al., 2015). We ran a linear regression with emotional tone as the dependent variable and frame (gain or loss framing from Study 1a) and

affect level manipulation (high affect from study 1b versus standard affect from Study 1a) as the independent variables. Gain framing resulted in higher emotional tone $\beta = 7.075, p < .0001$ and our high-affect manipulation did indeed lower emotional tone, $\beta = -7.245, p < .0001$, with no interaction and with the intercept being 49.75, ($F(3,408) = 9.02, p < .0001$), $R^2 = .06$.

We also ran additional analyses to determine if the number of emotional words predicted choice. Using LIWC categories for negative and positive emotions, we ran a logistic regression including frame and affect-level and found no incremental effect of any of either positive or negative emotion frequency on choice, above and beyond their relationship to frame and affect condition.

Study 1 - Discussion

As predicted, the emotional valence of the two frames guides attention, attracting attention to the positive certain option and repelling attention away from the negative certain option, which drives query order and produces differences in choice that are completely mediated by the different structures of thought. Gain frame decision-makers list pro-certain thoughts earlier and more frequently than decision-makers in the loss frame. The structure of thoughts plays a mediating role on choice, in both the low and the high affect choice scenarios. Differences in the frequency of positive or negative emotions in thought listings, in contrast, do not predict choice above and beyond the situational variation in frame and affect level.

Study 2a – The effect of thought order on choice

Materials and Procedure

If a difference in implicit query order is responsible for outcome framing effects, then explicit requests to use a specific query order should also affect choice. Previous QT studies have

attenuated the endowment effect (Johnson et al., 2007), asymmetric discounting in intertemporal choice (Weber et al. 2007), and attribute framing (Hardisty, Johnson, and Weber 2010), by explicitly manipulating the query order used by decision-makers. Thus, in Study 2, we directly manipulated the order of queries. Participants, seeing either the gain-framed or loss-framed choice, were instructed to first generate pro-certain thoughts followed by pro-risky thoughts, or vice versa. Listing pro-certain thoughts first (i.e., the order that decision-makers used spontaneously in Studies 1a&b) would be the “natural” query order for the gain frame and the unnatural order for the loss frame. In contrast, listing pro-risky thoughts first would be the natural order for the loss frame and the unnatural order for the gain frame. We hypothesized, consistent with Weber et al. (2007), Johnson, Häubl, and Keinan (2007), and Hardisty, Johnson, and Weber (2010), that by reversing the implicit query order, we would reverse or at least reduce the framing effect.

Participants

For the four groups (two frame and two query orders), we recruited 584 participants (263 female), ranging between the ages of 18 and 72, mean 33.26, SD = 10.46 with 124 having an education level of at least some college from Amazon Mechanical Turk. An attention check question removed 50 participants.

Results

As seen in Figure 10, in the natural thought listing condition, the proportion of participants that chose the certain option was greater in the gain frame, .77, 95% CI = [.69, .84], than in the loss frame, .37, 95% CI = [.29, .46]. The difference in proportions when subtracting

loss frame from gain frame was .40 with a 95% CI of [.29, .51]. There was a significant difference in proportion of participants choosing the certain option ($\chi^2(1, N=270) = 42.92, p < .001$). In the unnatural thought listing condition, the proportion of participants that chose the certain option was greater in the gain frame, .65, 95% CI = [.56, .73], than in the loss frame, .48, 95% CI = [.40, .57]. The difference in proportions was .17 with a 95% CI of [.05, .29]. There was a significant difference in proportion of participants choosing the certain option ($\chi^2(1, N=264) = 7.05, p = .0079$). Even though significant in both cases, the effect of framing is less than half for the unnatural query order than the natural query order condition.

To show the effect of both frame and thought order on choice, we performed an effect coded logistic regression, with answer defined by frame, thought order, and the interaction between frame and thought order. The main effect of frame was significant ($\beta = .61, SE = .09, p < .001$) and the interaction term was significant ($\beta = -.26, SE = .09, p = .004$). This interaction shows that having participants list their thoughts in the unnatural order, as compared to the natural order, reduces the likelihood of choosing the certain option in the gain frame and increases the likelihood of choosing the certain option in the loss frame. The model accounted for approximately 13 percent of the variance (Nagelkerke $R^2 = .13$)

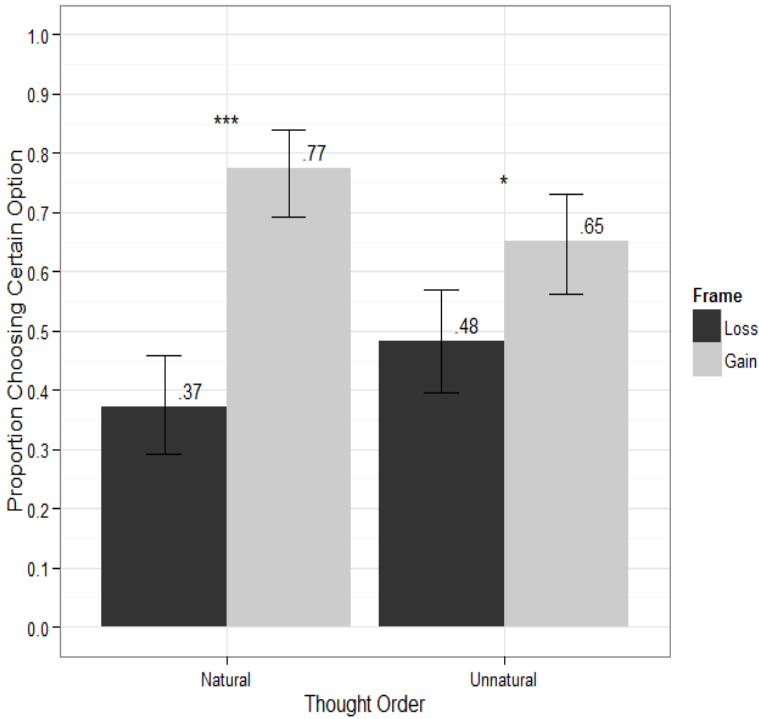


Figure 10. Percentage of people choosing the certain option for the natural and unnatural thought listing conditions.

While the logistic regression model included the predicted interaction between query order and frame, it still did not account for a large amount of variance in choices. Additionally, query theory posits that, due to output interference, initial queries bias the balance of thoughts. In order to address these two questions/concerns, we added Balance of thoughts to the regression model. We did not add SMRD as, by design, it was forced to the extreme values of -1 or 1. This regression allowed us to investigate our proposed mechanism for the interaction between query order and frame, namely that initial queries bias future queries, resulting in a larger balance of thoughts towards initial queries. As before, there was a significant effect of frame ($\beta = .63$, $SE = .10$, $p < .001$), no significant effect of mandated query order ($\beta = .073$, $SE = .10$, $p = .49$), but this time no longer a significant interaction between frame and mandated query order ($\beta = -.08$, $SE = .11$, $p = .45$). Instead, there now was a significant effect of balance of thoughts on choices ($\beta =$

.86, $SE = .1$, $p < .001$). The new model accounted for approximately 35% of the variance in choices (Nagelkerke $R^2 = .35$).

Study 2b – The effect of thought order on choice with affect

In Study 2a we were able to show that by explicitly changing the structure of thoughts, we can attenuate the amount of individuals who will choose the certain option. Different categories of affect have been shown to moderate the effect of frame on choice. With the addition of high affect, we wanted to test if changes to the query order would continue to influence choice regardless of level of affect. In Study 2b we wanted to see if the explicit reversal of the natural thought order in a high affect scenario would lead to a greater attenuation or maybe a reversal of the natural proportion of individuals choosing the certain option.

Method

Participants

For the replication of Study 2b, we recruited 593 (310 female), age range from 18 to 74, mean = 34.71, SD = 11.62, with 182 with at least some college education, from Amazon Mechanical Turk. Participants who failed an attention check question ($n = 17$) were removed from the analyses.

Materials and Procedure

Study 2b replicated Study 2a with the addition of the high affect scenario introduced in Study 1b. All procedures were identical to Study 2a.

Results

As seen in Figure 11, in the natural thought order condition, the proportion of participants that chose the certain option was greater in the gain frame, .74, 95% CI = [.65, .81], than in the loss frame, .35, 95% CI = [.27, .44]. The difference in proportions between gain and loss frame was .39 with a 95% CI of [.25, .50]. This was confirmed by a Chi-Squared test in proportion of participants choosing the certain option ($\chi^2(1, N=271) = 39.37, p < .001$). Also, in the unnatural thought listing condition, the proportion of participants that chose the certain option was greater in the gain frame, .66, 95% CI = [.58, .73], than in the loss frame, .51, 95% CI = [.43, .59]. The difference in proportions was .15 with a 95% CI of [.04, .26]. There was a significant difference in proportion of participants choosing the certain option ($\chi^2(1, N=305) = 6.20, p = .01$). As predicted, the effect of framing was much reduced in the unnatural-order thought listing condition.

To show the effect of both frame and thought order on choice, we performed an effect coded logistic regression, with answer defined by frame, thought order, and the interaction between frame and thought order. The main effect of frame was significant ($\beta = 1.65, SE = .27, p < .001$), the main effect of thought order was not significant ($\beta = .36, SE = .26, p > .1$), and the interaction term was significant ($\beta = -1.0376, SE = .35, p = .0035$). This interaction shows that that having participants list their thoughts in the unnatural order, as compared to the natural order, reduces the likelihood of choosing the certain option in the gain frame and increases the likelihood of choosing the certain option in the loss frame. The model accounted for approximately 11 percent of the variance (Nagelkerke $R^2 = .11$).

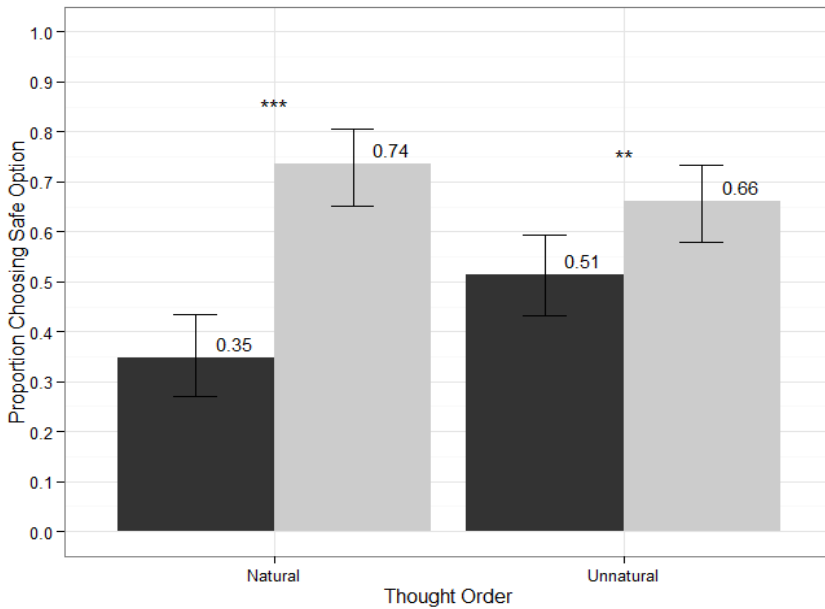


Figure 11. Percentage of people choosing the certain option for the natural and unnatural thought listing in high affect condition

As with Study 2a, we added Balance of thoughts to the previous regression. There was again a significant effect of frame on choices ($\beta = .55, SE = .09, p < .001$), no significant effect of mandated query order ($\beta = .09, SE = .9, p = .32$), but no longer a significant interaction between frame and thought order ($\beta = .15, SE = .95, p = .11$). Instead, there was a significant effect of balance of thoughts ($\beta = .27, SE = .7, p = .002$). The model accounted for approximately 14% of the variance in choices (Nagelkerke $R^2 = .14$).

Study 2a and 2b – Affect manipulation check

Studies 2a and b and ran a linear regression with emotional tone as the dependent variable and frame (gain or loss), manipulated affect level (standard affect in Study 2a or high affect in Study 2b), and mandated query order (natural or unnatural) as the predictor variables. Gain framing results in higher emotional tone ($\beta = 6.68, p < .0001$), higher affect level in lower emotional tone ($\beta = -3.47, p < .01$), with no interaction and no effect of mandated query order ($\beta = -.33, p = .77$) and an intercept of 61.58, ($F(7, 1102) = 6.322, p < .0001$), and $R^2 = .04$.

We also ran additional analyses to determine if the presence of emotional words predicted choice. As before, the frequency of positive or negative emotion words did not predict choice above and beyond these condition predictors.

Study 2 - Discussion

By having participants generate thoughts for the two choice options in an unnatural order, we were able to attenuate the effect of frame on choice. Our ability to attenuate the effect by interrupting the natural order of preference creation provides causal evidence of a link between order of choice option consideration and subsequent choice. We also establish a role for QT in valence framing effects. These identified processes obviously provide an entry point for debiasing this kind of framing effect.

As predicted, our explicit query-order instructions (both in the natural and unnatural order conditions) eliminated the effect of the differential affect strength of the choice scenarios in Study 1a vs. 1b. This is additional evidence that the stronger framing effect observed in the high-affect scenario of Study 1b over the low affect scenario in Study 1a was mediated by a stronger difference in query order, as measured by SMRD. Once SMRD was determined by task instructions in Study 2, the low vs. high affect scenarios of Studies 2a and 2b, respectively, no longer led to differences in the effectiveness of choice frame.

The amount of affect expressed did not differ between the natural and unnatural order condition. Changing the order of thoughts does not seem to change how you feel about the choice options, but it does change the balance of thoughts and hence the final choice.

General Discussion

Risky choice framing is a well-studied phenomenon, with prospect theory describing the functional relationship between outcomes framed as either gains or losses and their impact on

choice. The studies reported above that identify the QT mechanisms behind risky choice framing effects are not intended as competing with the prospect theory account, but rather as identifying the psychological processes in terms of attention and information aggregation that bring about the functional relationships described by PT. Our results extend QT to explain the processes behind risky choice framing, showing that a positively-framed certain option will attract attention and initial questioning of reasons for choosing it, but that a negatively-framed certain option will repel attention, leading to initial questioning of reasons to choose the risky option.

Our QT analyses showed that query order and resulting balance of thoughts varied by frame – in the gain frame participants listed pro-certain thoughts earlier and more of them than in the loss frame – and that this balance of thoughts mediated the effect of frame on choice. In fact, risk attitude under either frame (i.e., whether the decision maker picked the risky or the certain option) was well predicted by QT and its balance of thoughts. This illustrates that attentional processes and resulting internal argument search and value construction processes generate the effect of frame on preference when decision-makers face an unfamiliar risky choice.

Additionally, we found that reversing participants' natural query order attenuated the effect of frame on choice, strong evidence of a causal mechanism (Hardisty et al., 2010; Johnson, E. et al., 2007; Weber et al., 2007). Increasing affective response to the choice scenarios increased the framing effect, as it did in previous studies (Lerner & Keltner, 2000; Lerner, Li, Valdesolo, & Kassam, 2014), and we found that attraction of the certain outcome in the gain frame and the repulsion of certain outcome in the loss frame were the driving force behind this. Our query-order interventions in Studies 2a&b successfully forced a shift in choices, with the requested explicit unnatural query orders decreasing the framing effect, but presumably the

automatic attentional effects guided implicit natural order queries that were strong enough to still generate the typical risky choice framing effect, only at a reduced level.

Chapter 2: Choice Architecture and Behavioral Spillover

Choice architecture tools most often help people make objectively (and subjectively) better decisions by either bypassing or decreasing the cognitive effort and resources or by focusing attention on specific factors of the decision. At the same time, in bypassing more cognitively engaged routes to decision-making, the use of certain choice architecture tools (e.g., default setting) may come with a previously unappreciated cost, namely, a decrease in positive spillover effects. Tools that focus attention (e.g., social norm and negative affect) may have different effects on behavioral spillover.

Study 1

In Study 1, we explore the effects of default setting on behavioral spillover. Default setting is one of the most replicated choice architecture tool and is regarded as the strongest one (Brown & Krishna, 2004; Johnson et al., 2012; Sunstein, 2013; Thaler & Sunstein, 2008). In this study, we set a default for an initial pro-environmental action, donating to an environmental charity. Then we measure participant's environmental identity and their future pro-environmental behavioral intentions. We set three levels of default based on proportion of bonus to donate (zero, half, and all). There was a fourth condition without a default. Participants in this condition had to type in the amount to donate in a blank box. The no-default condition was used as the control condition. Given the underlying mechanism of defaults, cognitive effort and implicit recommendation, we expect that individuals in the conditions with the higher default donate amount will donate more to charity than individuals in the lower default amount and the individuals in the no default conditions. However, in the conditions with no or lower donation defaults, individuals who want to donate and do donate will have to overcome the no-donation

default to change their donation amount. We also predict that those who donate under those conditions will show greater spillover behavior, self-reported, future pro-environmental behavior to maintain behavioral consistency.

Method

Participants

For Study 1, we recruited 309 (137 female) respondents, ranging between 18 and 71 years old with a mean age of 34.77, $SD = 10.86$, with 165 reported having an education level of some college or higher, from Amazon Mechanical Turk. An attention check question removed 12 participants.

Materials and Procedures

After completing another, unrelated task, participants were told they were going to receive a one dollar bonus. After they were told about the bonus, they were presented with the opportunity to donate some or all of the bonus to an environmental charity. Participants were given a short description of the charity and the charity website for further information. After the description, participants were randomly assigned to one of four conditions; Default Donate, Default Keep, Default 50/50 and No Default. All of the default conditions utilized a slider with a minimum value of zero and a maximum value of one dollar to determine how much they wanted to donate to the charity. The defaults were the initial starting point of the slider on the scale with Default Donate starting on the maximum value (\$1) the Default Keep slider starting on the minimum value of the scale (\$0) and the Default 50/50 slider starting in the middle of the scale (\$0.50). Participants in the No Default condition were asked to input the amount they wanted to give in a text box; No Default was used as the control condition. After deciding the amount they wanted to donate, participants rated how highly they identified with specific identities (e.g., Are

you an Environmentalist?, Are you a Conservative?, Are you a Ruralite (Do you enjoy country living?) from “Not at all” (1) to “Completely” (5). Only the environmentalist question was analyzed for these studies, the other questions were used to reduce expectation effects.

Participants then answered how they would partake in 12 future environmentally conscious behaviors using a Likert scale of “Never” (1) to “All the time” (6). Seven of the behaviors were ones that they could do in the next month, including taking shorter showers and turning off lights when leaving the room, and five behaviors were ones that they could do in the next year, which included less frequent behaviors such as purchasing a carbon offset for air travel.

Results

The one way ANOVA used to test the effect of condition on donation behavior indicates that none of the condition differed significantly from the each other ($F(2,291) = .397, p = .756$) and the overall mean donated was \$ 0.21, $SD = 0.30$. Condition failed to influence donation behavior. While we could not detect an effect of condition on donation behavior, donation behavior did have an effect on future intentions, our spillover measure. In Table 1 we see that as donations increased, $\beta = .334, p < 0.001$, so did participant’s behavioral intentions score.

Table 1. Linear Regression Modeling Pro-environmental Intentions by Condition

	Estimate	Std. Error	t value	<i>p</i>	
(Intercept)	2.411	0.141	17.129		
Default Donate	0.096	0.130	0.740	0.460	
Default Keep	-0.143	0.134	-1.069	0.286	
Default 50/50	0.129	0.129	0.999	0.319	
Donation	0.350	0.156	2.241	0.026	*
Environmental Identity	0.334	0.042	7.911	<0.001	***

Discussion

In study 1, while we did not achieve the expected default effect, we did get interesting results and information applicable to future studies. Participants who donated more of their study bonus to an environmental charity, holding environmental identity constant, also intended to do more pro-environmental behaviors in the future, our spillover measure. This supports the theory of behavioral consistency, a mechanism of positive spillover.

The main effect of donation amount on behavioral intent was present, but there was no effect of condition on our measure of spillover behavior (i.e., intention to do more pro-environmental behaviors). Considering the historic strength of defaults, why was there no effect of condition on donation behavior? We believe that the default setting that we used, slider location on a number line, was overlooked by the participants. Sliders may not have been viewed as preselection or implicit recommendation, and thus we believe that the participants did not go through the mechanisms of default, as demonstrated by participants in all conditions donating the same average amount. Without an effect of default, we cannot assume that a strong or true default effect would continue to have positive behavioral consistency, positive spillover, and avoid negative behavior consistency (negative reactance to the default and continued reduce behavior in the subsequent behavior) or negative spillover (moral licensing). We also cannot assume that our findings would be the same if we found a default effect. These individuals who donated and were also consistent, might be the individuals who would have completed these tasks regardless of the question. We miss the spillover information about individuals who were may have decided to donate because of the default setting.

Study 2

Given the robustness of default effects demonstrated in the literature, the failure to elicit an effect in Study 1 suggested that the paradigm we developed was not strong enough to influence initial behavior. We believe that the initial location of the sliders might not have been viewed as a recommendation or a preselection (mechanisms of default setting) in the way that is traditionally observed in previous literature through preselected check boxes. In Study 2, we move from sliders to a preselected check box to strengthen the initial default setting. This is consistent with how defaults are presented in the literature and we believe will lead to the default effect. Once participants show a clear effect of default on the first behavior, we will be able get a clearer look at downstream effects on subsequent behavior and of the intervention.

We also developed a measure of behavioral spillover (rather than a self-report measure of future intentions) to capture possible spillover effects. Since there are many behaviors that could be spillover behaviors, and choosing just one spillover behavior to measure might leave another behavior unobserved, spillover can be hard to measure, specifically in laboratory settings. The one behavior that is the focus of a lab or field study may not be the one that respondents exhibit, and the study might miss slightly different spillover behaviors, and different individuals may exhibit different spillover behaviors. To address this, we developed a diverse information seeking measure; participants were given the opportunity to view websites with information about how to be a more pro-environmental person. These websites represent an array of different domains to be a more pro-environmental person. We feel that this broader measure of spillover will help us to observe spillover in this study, fundamental to pinpointing the effect in these early studies. Based on the evidence of behavioral consistency and the results of Study 1, we hypothesize that individuals who are defaulted to complete the first behavior, donating their

bonus, will donate at a higher rate and will seeking out more pro-environmental information (i.e., click on more websites), and thus show positive behavioral spillover.

Method

Participants

We recruited 902 (53% female) respondents, ranging between 18 and 75 years old with a mean age of 34.14, $SD = 11.64$, from Amazon's Mechanical Turk. We removed 116 participants for incomplete responses. Removed participants were equally distributed between conditions.

Procedure

After completing an unrelated task, participants were given a bonus of one dollar and presented with the opportunity to donate to an environmental charity. Participants were given a short description of the charity and the charity website for further information. After the description, participants were randomly assigned to one of two conditions; Donate or Keep. In the donate condition, participants were defaulted to donate all of the bonus. Participants had to make an active choice (i.e., click an extra button) if they wanted to keep the bonus. The keep condition was the opposite: the default option was to keep the entire bonus, with extra effort being required in order to donate the money to the charity. After deciding whether they wanted to donate or keep the bonus, participants rated how highly they identified with specific identities (e.g., environmentalist, conservative) from "Not at all" (1) to "Completely" (5). In addition to identity, we added the measure of information seeking behavior. At the end of the experiment, participants were given an opportunity to learn how they could take further steps to help environmental issues. They were presented with six web links, each connected to a different website with information about various environmental issues (e.g., eat less meat, signing

petitions, emailing elected officials about climate change). Our measure of downstream behavior was the number of links each participant clicked on.

Results

There were two outcome variables of interest: the effect of default setting on donation behavior and the effect of default setting on non-targeted, downstream information seeking (i.e., spillover). As shown in Table 2, the level of default (donate vs. keep) has a significant effect on the targeted donation behavior, with those in the default donate condition donating 27.8%

Table 2. Chi Square of Proportions Donated

Condition	Kept Bonus	Donated Bonus
	n (%)	n (%)
Default Keep	322 (82.1)	70 (17.9)
Default Donate	285 (72.2)	110 (27.8)

$\chi^2 = 11.13, p < 0.001$

of the time, almost 10% more than individuals in the default keep condition, 17.9%, $\chi^2 = 11.13, p < 0.001$

In Table 3, we see that defaulting individuals into donating significantly increased donation rates, $\beta_{\text{Default Donate}} = 1.775, p = .001$. Individuals in the default donate condition were 1.7 times more likely to donate than individuals in the keep condition. When added, the covariate Environmental Identity also significantly predicted donation behavior, $\beta_{\text{Env identity}} = 1.432, p < 0.001$, and resulted in a slight reduction in the effect of default donate, $\beta_{\text{Default Donate}} = 1.771, p = .001$. Environmental identity will be controlled for in subsequent analyses

Table 3. Logistic regression modeling donation of bonus by default condition

	Model 1	Model 2
	OR (95% CI)	OR (95% CI)
Default Keep	REF	REF
Default Donate	1.775 (1.265, 2.492)***	1.771 (1.255, 2.498)**
Environmental Identity	--	1.432 (1.237, 1.657)***

OR = Odds Ratio, 95% CI = 95% Confidence Intervals

Asterisks refer to p-values (* p < 0.05, ** p < 0.01, *** p < 0.001)

More critically, the default setting also influenced non-targeted information seeking behavior, providing evidence of a spillover effect. As shown in Table 4, using a Poisson regression to predict counts of spillover behavior, we find a significant interaction of default condition (donate vs. keep) and initial decision (donate vs. not donate) on information seeking, $\beta_{\text{Default Donate : Donate}} = 1.572, p = .018$. Individuals who were in the default *donate* condition and who donated were clicked nearly 1.6 times as many links as those in the default *keep* condition and who donated. In contrast, individuals in the default *donate* condition who did not donate were less likely to seek out additional information about environmental issues relative to those in the default *keep* condition who did not donate, $\alpha_{\text{Donated}} = .752, p = .010$.

Table 4. Poisson regression modelling behavioral spillover predicted by default setting

	Estimate (RR)	Robust SE	LL	UL	<i>p</i>
(Intercept)	0.459	1.258	0.293	0.719	
Default Donate	0.752	1.242	0.492	1.149	0.010 *
Donated	1.354	1.340	0.763	2.403	0.037 *
Environmental Identity	1.134	1.079	0.977	1.316	0.001 **
Default Donate: Donated	1.572	1.501	0.709	3.487	0.018 *

We further stratified the Poisson regression to understand the effect of condition on spillover behavior. As shown in Table 5, there is no significant difference between the

conditions in spillover behavior by those who donated. However, the individuals who kept their bonus in the Default Donate condition, were less likely to click on links than the individuals in the Default Keep condition.

Table 5. Stratified Poisson regression modelling links clicked (spillover) by default condition and initial action

	Donated Bonus	Kept Bonus
	Effect (95% CI)	Effect (95% CI)
Default Keep	REF	REF
Default Donate	1.280 (0.682, 2.400)	0.774 (0.513, 1.168)*
Environmental Identity	1.410 (1.004, 1.980)***	1.020 (0.889, 1.171)

OR = Odds Ratio, 95% CI = 95% Confidence Intervals
 Asterisks refer to p-values (* p <0.05, ** p <0.01, *** p <0.001)

Discussion

Findings of Study 2 provide evidence of a complex spillover effect induced through the use of a default that promotes positive environmental behavior (i.e., making a donation to an environmental non-profit organization). As expected based on past literature (Johnson & Goldstein, 2003), the positive default significantly increased the incidence of the targeted behavior. Taken alone, this finding seems to support the use of positive defaults in the environmental domain. However, it is critical to also consider the somewhat complex effects of default setting on subsequent, non-targeted behavior. In this study, we found that when the default “worked” (when it encouraged individuals to make the donation), individuals were more likely to engage in subsequent positive action (i.e., seek out additional information about environmental issues and ways of becoming more engaged). This subsequent positive action may indicate a positive spillover effect or, at least, the effects of behavioral consistency that are supported using a positive default.

However, the results also reveal a potentially problematic outcome of this spillover effect: individuals who were initially defaulted to make a donation, but who decided to switch away from the donation (i.e., keep the money) were significantly less likely to take subsequent action than were those who failed to make the donation after being defaulted into keeping the bonus money. The effect persists after controlling for environmental identity, indicating low pro-environmental identity was not the driving force behind the reactance behavior. Put another way, for the people who pushed back against a positive default, we observed a negative spillover effect, possibly induced through a combination of reactance to the initial behavioral intervention (i.e., the default) and a behavioral consistency effect. Thus, at least for some people, the positive default influenced them to do *less* pro-environmental behaviors, both initially and also subsequent to the intervention. The results of the study suggest that although defaults can induce positive behavioral consistency, they may also act to unintentionally reinforce undesired behaviors in individuals who reject the initial default. If robust, this counter-productive effect of defaults may significantly undermine the net gains made through the setting of pro-social, pro-environmental defaults.

Study 3 – Choice Architecture Tools and Spillover

With the evidence from Study 2 showing that behavioral spillover can be modelled in the lab environment and that choice architecture has an effect on behavioral spillover, we expand our research to include a choice with multiple defaults. In addition to default setting, we added two well-known and frequently used choice architecture tools, social norms and negative affect. Truelove and colleagues (2014) posited that positive or negative spillover behavior can be affected by the decision mode that leads to the first action as well as by the difficulty level of

both the first and the subsequent action, but the authors do not propose the direction of the effect of defaults on spillover behavior. Social norm has been associated with positive spillover behavior and negative affect with negative spillover behavior. In Study 3, we aim to determine the relative effect of defaults, social norm and negative affect on initial behavior and spillover behavior. We predict that defaults will have the greatest positive effect on the initial behavior, that social norms will lead to positive spillover behaviors and negative affect will lead to negative spillover behavior.

Method

Participants

For Study 3, we recruited 1058 (42% Female) respondents, ranging between 18 and 75 years old with a mean age of 58.05, $SD = 25.56$, from Amazon's Mechanical Turk. We removed 59 participants for incomplete responses.

Procedure

Participants were presented with a short vignette about moving into a new apartment complex. The apartment complex is lauded as one of the more attractive complexes at the price point. Participants were then randomly assigned to one of four conditions, Opt-Out, Opt-In, Social Norm, and Negative Affect.

For the Opt-Out condition, participants saw the below text.

“The landlord of your apartment complex has decided that all of the apartments by default will include a number of green amenities, listed below.

These green amenities will be included in your rent. However, if you would like any of these green amenities NOT to be installed, the landlord will deduct the cost of that amenity from your monthly rent (you will pay between \$2 and \$10 less per month for each amenity you omit). If you choose to omit a premium amenity, you will receive the standard version of that amenity rather than the green upgraded version.

You can therefore keep all of the green amenities that are included in your rent, or choose to receive the standard rather than green version of some or all of the amenities and pay a reduced amount each month. ”

For the Opt-In condition, the landlord provides tenants with the opportunity to choose any of the green amenities, for a commensurate increase in monthly rent, but the default setting is to have the “brown” option for each amenity.

“The landlord of your apartment complex has decided that all of the apartments by option can include a number of green amenities, listed below.

These green amenities are NOT included in the standard rent. However, if you would like any of these green amenities to be installed, the landlord will add a small amount (between \$2 and \$10, depending on the item) to your monthly rent for each of the amenities you choose to add.

You can therefore add all of the green amenities, or choose to receive the standard rather than green version of some or all of the amenities and pay the standard amount each month.”

The Social Norm and the Negative Affect conditions are variations on the Opt-In condition. In the Social Norm Condition, the landlord informs the participants that “76% of the tenants” chose all of the green amenities, thus highlighting that although the green options are indeed optional, the norm amongst individuals living in this complex is to opt for the more expensive, “green” amenities. In the Negative Affect condition, the landlord informs the hypothetical tenant of the amount of carbon emissions produced if they keep the “brown” options (2.8 metric tons), translating that number into other metrics to reinforce its significance (e.g., equivalent to 3,000 lbs. of burned coal; they would be producing between 5 and 10% more emissions than their neighbors). After receiving the information from the landlord, all participants in the Opt-In, Social Norms and Negative Affect conditions read the following:

These green amenities are NOT included in the standard rent. However, if you would like any of these green amenities to be installed, the landlord will add a small amount (between \$2 and \$10, depending on the item) to your monthly rent for each of the amenities you choose to add. You can therefore add all of the green amenities, or choose to receive the standard rather than green version of some or all of the amenities and pay the standard amount each month.”

The amenities the participants were choosing were the following.

- Energy-star furnace & air conditioner
- Tankless water-heater
- Programmable thermostat
- Storm windows & doors
- Airflow-adjusting ceiling fans
- UV filter film on windows
- Energy-efficient dishwasher & refrigerator
- Compact Florescent (CFL) light bulbs
- Energy-efficient washer & dryer
- Dimmer switches for indoor lighting
- Low-flow toilets
- Solar-powered outdoor lighting
- Low-flow faucets & shower heads
- Motion sensors for outdoor lighting

In the Opt-out condition, all the amenities are preselected, and the choice is which, if any, of the green amenities to unselect. For all the other conditions, the amenities are not selected, and the choice is which amenity to select. After deciding on the amenities, participants were asked to donate to a charity. This donation came out of a bonus they received and not from their participation compensation. They were asked to donate up to one dollar in one-cent increments. After deciding how much to donate and how much to keep, participants rated how highly they identified with specific identities (e.g., environmentalist, conservative) from “Not at all” (1) to “Completely” (5).

Results

We used the number of amenities selected as the first dependent variable in order to measure the effect of the choice architecture tools on targeted behaviors. The amount donated to charity serves as a non-targeted, downstream action and thus provided an opportunity to look for spillover effects. Table 4 displays the results of a linear regression run to determine the effects of the treatment conditions on the initial, targeted behavior (choice of green amenities), while controlling for environmentalist identity. Changing the default from Opt-In to Opt-Out significantly increased the number of environmental amenities picked by participants, $\beta_{\text{Opt-Out}} = 4.40, p < 0.01$. On average, the Opt-Out participants selected four more amenities than those in the Control condition. The Negative Affect and Social Normative control did not show a significant difference from the Opt-In only condition, indicating that these additional pieces of information did not significantly influence the targeted decision.

Table 6. Linear model of Amenities Chosen by Condition

	Estimate	Std. Error	t value	<i>p</i>	
(Intercept)	4.646	0.235	19.742		
Opt Out	4.401	0.270	16.277	< 0.001	***
Negative Affect	-0.239	0.269	-0.887	0.375	
Social Normative	-0.155	0.270	-0.572	0.567	
Environmental Identity	0.483	0.087	5.543	<0.001	***

As indicated in Table 5, participants who selected more amenities, also donated more to the environmental charity, $\beta_{\text{Amenities}} = .92, p = < 0.01$. For each appliance selected, on average, the participants donated almost one percent more money to charity.

Table 7. Linear Model of Charity Donation by Apartment Amenities

	Estimate	Std. Error	t value	<i>p</i>	
(Intercept)	9.0411	2.5181	3.59		
Amenities	0.9215	0.3007	3.064	0.002	**
Environmental Identity	7.9007	0.9984	7.914	< 0.001	***

In Table 6, we explored the relationship between the conditions, the amount of amenities selected, environmental identity, and amount donated. The more green amenities an individual selected, the more money he or she donated to charity, $\beta_{\text{Amenities}} = 1.3385$, $p < 0.001$, after controlling for condition. The Opt-Out condition is the only manipulation that we are able to

Table 8. Linear Model of Donations by Condition

	Estimate	Std. Error	t value	<i>p</i>	
(Intercept)	8.7559	3.1393	2.789		
Opt Out	-6.8092	3.4391	-1.98	0.048	*
Negative Affect	-2.0905	3.0459	-0.686	0.492	
Social Normative	0.881	3.0633	0.288	0.773	
Amenities	1.3385	0.3587	3.732	< 0.001	***
Environmental Identity	7.6629	1.0033	7.638	< 0.001	***

determine a significant difference than the Control. In contrast to earlier models, where the Opt-In condition predicted an increase in environmental amenities, this model predicted a decrease in donation amount to the pro-environmental charity, by about 6.8%, $\beta_{\text{Opt-Out}} -6.81$, $p = 0.048$. Individuals who had the pro-environmental default settings for amenities (all the green amenities were preselected), on average, donated less money to the pro-environmental charity than the Opt-In condition.

Study 3 - Discussion

Using a distinct paradigm, results of Study 3 closely mirrored and replicated those of Study 2. Setting a positive default (i.e., including the price of “green” amenities in the initial cost of an apartment rental agreement) significantly increased the number of such amenities that hypothetical tenants (respondents) chose to keep. These findings replicate findings of Pogacar, Steffel, Williams, and Figueras (2014), who designed the original default setting vignette. However, participants defaulted into choosing more green amenities subsequently donated less money to an environmental charity (after controlling for the number of green amenities chosen), revealing a negative behavioral spillover effect of the default on non-targeted, but goal-consistent action. These effects held after controlling for individual differences in pre-existing environmental concern (i.e., environmentalist identity).

We did not observe an effect of social norm or negative affect on either the first or the second behavior. We believe this failure could be the result of vignette. This hypothetical situation has been validated for a default effect, but has not been validated for other choice architecture tools. The mechanism of social norm (identity reinforcement and group affiliation) and of negative affect (addressing a negative emotional plea) may not have been sufficiently engaged in the story. Future studies should strengthen the social norm and negative affect pleas to properly motivate the decision maker. This could be done by using a real scenario, where the negative outcomes are tangible and can be traced back to the individual or where the identity reinforcement and group is more salient and genuine. In addition to strengthening the intervention, a manipulation check should also be added to better understand of the boundary conditions between success and failure for social norm and negative affect intentions.

General Discussion

While we failed to observe a default effect in Study 1, we were able to show that initial pro-environmental behavior could lead to increased intentions to engage in future pro-environmental behavior. This result suggests that behavior influences future behavior. In Study 2, we showed two potential outcomes from default setting, reactance and spillover behavior. Individuals who were defaulted to give to an environmental charity, and who gave to the charity, also showed greater interest in pro-environmental information. Individuals who rejected the default settings, were less likely to click on the links than the individuals who had the choice to opt-in to donate and chose not to donate. More people would pursue additional pro-environmental behaviors if they were not defaulted into the first environmental behavior. In Study 3, individuals who were defaulted to pro-environmental behaviors donated less to environmental charities. Based on these findings, we conclude that defaults cannot be used without forethought. While default setting remains a good option for encouraging greater pro-environmental behavior, their use may come with a previously unidentified downside, namely, reactance and negative spillover effects.

We also failed to influence behavior using social norm and negative affect approaches in Study 3. The comparison between social norm, negative affect and default is one that needs to be addressed in future research. In order to better quantify differences in the overall effect of the first behavior combined with subsequent behaviors, we need direct comparisons between the three conditions. Future research should continue to include all three choice architecture tools in single studies to explore how to maximize the complete outcome and not just the initial choice. Exploring effectiveness of each of these tools in direct comparison allows us to better understand the magnitude of each choice architecture tool. Once we better understand each tool

individually, we can take the next steps in understanding how to use certain tools together to maximize the strengths and minimizing weaknesses. For instance, combining default setting with social norm to use the strength of default to increase the initial behavior and the strength of social norm to increase the likelihood of subsequent behaviors.

The observed spillover effects of default setting in the environmental domain poses a potential threat to the long-term efficacy of this approach for behavior change. While Truelove and colleagues (2014) did not specifically address default setting, they did theorize that the difficulty of the behaviors (initial and subsequent) and the order of the two behaviors (i.e., difficult behavior followed by an easier behavior or vice versa) could lead to different spillover effects. Therefore, one explanation of the results of Study 2 and Study 3 are differing levels of engagement in the initial choice. Using a choice architecture tool that reduces the effort required to make a decision should lead to spillover effects depending on the strength and application of default setting. In Study 1, the default setting was too weak to reliably lead to a default effect, but those who donated showed greater future intentions. Individuals who made the decision to donate, used effort to make the decision not only to donate, but also to decide on the amount to donate. This effort led to the positive spillover behavior. For Study 2, we increased the strength of the default, which led to both a default effect and positive spillover. Further, the initial and the subsequent behavior were easy to complete and the subsequent choice was in-line with the already completed behavior. Consistent with the literature, we observed that behavioral consistency can be a large motivator in choice behavior (Festinger, 1962). In Study 3, the initial behavior easy to complete, but the subsequent behavior was more difficult to complete. While the default setting indicates the preferred outcomes of the choice architect, taking the pro-environmental amenity, this sentiment might not have been internalized by the decision making.

One interpretation is the effortless initial decision, followed by a complex subsequent decision led the decision makers to donate less money than individuals in the Opt-in condition.

These secondary effects must be considered and weighed when deciding whether or not to use default settings—and perhaps other choice architecture tools believed to operate in a similar fashion—in any particular campaign or behavior change effort. Considerable research exploring the long term effects of incentivized behavior has helped to differentiate the effects of both internal and external motivation on behavior change (Deci, Koestner, & Ryan, 1999). The use of defaults to influence behavioral change requires the same scrutiny.

The presence of negative spillover effects as a result of using positive defaults should not dissuade others from the use of these tools. Rather, identifying the scenarios that lead to reactance or negative spillover and the magnitude of the spillover can help to create better choice architecture tools to minimize the negative effects in those scenarios. For example, the initial, targeted behavior has a large impact (e.g., buying an efficient vehicle or appliance), it may be the case that any negative spillover effects are outweighed by the positive environmental impact of the initial behavior change. Future assessments of choice architecture tools should include measures of the impact of the targeted behavior change on actual behavior change, the effectiveness of the change in achieving the targeted behavior, and an assessment of gains in targeted behaviors compared to decreases in other, non-targeted behaviors. The last of these, comparing relative gains and losses in behaviors in specific scenarios, may be the most challenging to identify and quantify. Future research could be used to identify patterns that may exist with respect to *which* downstream behaviors are most likely to be negatively (or positively) influenced by individuals performing a targeted behavior as a result of an intentional default effect.

Chapter 3: Choice Architecture and Behavioral Spillover: Field Experiment

Using the framework developed by Truelove et al. (2014), our field experiment is a direct test of the theory behind behavioral spillover. The field experiment took place over one spring semester at Swarthmore College, a liberal arts college in the suburbs of Philadelphia, PA. We tested the effectiveness of pro-environmental messaging prompts on immediate and future pro-environmental behaviors among undergraduate students at a liberal arts college. Using the three decision modes, calculation-based (semi - control condition), affect-based (negative affect), and rule and role-based (social norms), as our three conditions, we measured the effect of three different messages designed to engage the different decision modes on immediate, sustained behavior change and spillover behaviors.

We separated the analysis of the field experiment into two studies. The first study contains the analysis of the individual level data. Here, we are measuring the effect of our three conditions on pre and post intervention surveys, recycling behavior and attendance of a summit on climate change. The surveys give insight into the self-report attitudes and levels of intentions and engagement towards environmental issues. The individual measures of recycling and summit attendance, give us objective behavioral measures of initial behavior (recycling) and spillover behavior (summit attendance).

The second study is the analysis of the group level differences in energy consumption as a function of the different messaging conditions. The different messaging conditions were administered at the building level (one message type per building). We will compare the effect of condition on energy consumption during three time periods, pre-treatment, treatment, post treatment. All occupants of the building received the same email. With this approach, we hope to observe behavior change absent of demand effects. While the students know that the surveys

are being collected and analyzed, they are not aware the energy consumption was being collected and compared between buildings.

The goal of these studies is to gain a better understanding of immediate and long term behavior when comparing the effect of information alone, social norm and negative affect messaging. These three conditions are theorized to lead to different spillover behavior. The information alone condition is our control condition and is parallel to the calculation based decision making. There are no expectations of spillover behavior for calculation based decision making. Social norm messaging should engage an individual to act in a manner that reinforces their identity, representing rule/role based decision making. As group identity increases, the individual will seek out ways to continue this reinforcement, leading to positive spillover. Negative affect uses a different motivation to encourage the initial behavior, negative emotions linked with the consequences of failure to do the initial behavior, our affect based decision mode. Reducing the negative emotions are the driving force behind behavior. Once the negative emotions are eliminated or reduced (behavior is completed), the motivation is also removed, leading to the individual being less likely to do the second behavior. We hypothesize that, based on the strong drive to address the uncomfortable feeling of negative affect, participants in the negative affect conditions will show greater participation in the initial behavior, but less in the subsequent and sustain behaviors, exhibiting negative spillover. In comparison, we predict that the individuals in the social norm condition will show a small increase in the initial behavior, but a larger increase and sustained behavior for subsequent behaviors. This small increase followed by a larger increase will be the result of identity reinforcement. Each time a behavior reinforces the individual's identity, the greater that identity will be represented in their decision processes. For Study 1, we predict that in comparison to the semi-control condition, individuals in the

negative affect condition will show greater participation in the recycling event, the initial behavior, but less participation during the summit, while individuals in the social norm condition will show both a moderate increased engagement in the recycling event and an increase in the summit attendance.

Study 1

Method

Participants

Participants were 302 (64.9 percent female) undergraduate students, ranging between 18 to 27 years of age, mean = 21.37, SD = 3.531 at a liberal arts college located in Pennsylvania. We counted participation if a student partook in at least one of three components of the study: 1) completed one or more of three online surveys; 2) participated in a plastic bag recycling drive; 3) attended the College's annual Sustainability Summit. Nineteen of the participants were also members of the Green Advisors (GA), a college run program that places students in dorms to facilitate environmental stewardship. The sample population represents 20.4% of the college's official enrolled 2016 Spring student population.

Materials

Surveys.

All matriculated students were invited via email to participate in a series of two online surveys. Participation in each of the surveys was optional and entry into a lottery was used to incentivize participation. Survey 1: Pre-Survey went out on Thursday, February 11, one prior to the email intervention. Survey 2: Mid-Survey went out on Tuesday, March 22, after the final email tip.

Survey 1: The Pre-Treatment survey included demographics, Environmental Actions Scale (EAS) (Alisat & Riemer, 2015), Behavioral Intention Scale, and Behavioral Engagement Scale. All the non-demographic survey items were Likert-type scales. The EAS is an 18-item measure level of engagement in civil environmental actions. The Behavioral Intention and Engagement Scale are 7 item scales developed to measure intention and engagement based on the theory of planned behavior (Fielding, McDonald, & Louis, 2008)

Survey 2: The Post-Treatment survey included demographics and the follow-up Behavioral Intention Scale, and Behavioral Engagement Scale. All the non-demographic survey items were Likert-type scales.

Emails.

All matriculated students received four (4) email tips (Appendix D), in addition to the two surveys, over the course of five weeks during the 2016 Spring semester. The emails originated from the Office of Sustainability promoting energy reduction and proper waste behavior. All the emails (Tips) were pro-environmental in nature. Though the content of the tips was consistent for all students, the framing varied among conditions. Conditions were randomized at the college residential building level. The three conditions were as follows: The Negative Affect condition (n = 93) focused on the negative outcomes if environmentally damaging behavior were to continue by the individual student (e.g., “Consider your contribution to carbon emissions... [The College] as a whole emits about 16,000 metric tons of carbon dioxide per year”). Emphasis was placed on reducing individual contribution to negative climate outcomes. The Social Normative condition (n = 97), focused on the pro-environmental actions being taking by members of the student body (e.g., “Your peers are working to help the College meet its goal of carbon neutrality by 2035”). Emphasis was placed on acting in line with the

student body and increasing pro-environmental behavior. The third condition was the Semi-Control condition. This condition focused on the numbers about current activity and climate change (e.g., “The College signed the American College & University President’s Climate Commitment in 2010 to move the institution toward carbon neutrality by 2035”). No emphasis was applied besides the simple calculations and the outcomes. These conditions were tracked for students who participated in online surveys and/or the subsequent Office of Sustainability events.

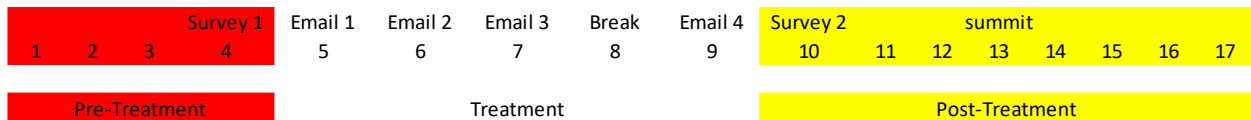


Figure 12. Study Timeline

Students received Survey 1 at baseline. Each subsequent week for three weeks, students received intervention Tips from the Office of Sustainability with information about the effects of energy usage and improper waste management and suggestions on how to improve their environmental behaviors. One last Tip was sent after a one week intermission for spring break. Following the Tip, students were sent Survey 2. Two weeks later, Survey 3 was distributed and students were invited to attend a campus-wide sustainability summit.

Recycling.

Included in the Tip 2 and Tip 3, was a plastic bag recycling request. Tip 2 had a statement to inform the students that there would be a plastic bag collection and how to participate in the collection.

*To help you dispose of tricky items, you will receive a brown bag that you can use to collect unwanted plastic bags. We will gather your plastic bag collections in about 10 days. Please write your [redacted] username on the brown bag and a Yes/No answer to the following question: Was this service useful? *

Tip 3 had a statement with the reason behind the plastic bag collection and date of plastic bag collection. To keep consistency, the recycling plea matched the condition.

Control condition:

Plastic bags can only be recycled at specialized facilities. We will host a plastic bag collection on 2/26/16 to bring the plastic bags to be properly recycled

Negative Affect:

You only use your plastic bags for minutes on average, but these same plastic bags have a lifetime expectancy of hundreds of years. Own up to your responsibility and partake in a plastic bag collection event on 2/26/16 to bring the plastic bags to be properly recycled.

Social Norm:

Proper waste management embodies [REDACTED]'s community values. Plastic bags can only be recycled at specialized facilities. Join your fellow dorm mates and the rest of the [REDACTED] community for a plastic bag collection event on 2/26/16 to bring the plastic bags to be properly recycled.

Results

The analysis of the individual level data show that roughly equal proportion of individuals responded to the surveys across conditions. To be considered a participant in the individual level analyses, students had to participate in at least one of the individual measures (a survey, donate plastic bags, or attend the sustainability summit). Table 7 show the number of students who took at least one survey, and the percentage of participants in each condition who completed a survey.

Table 9. Participation in Surveys by Condition

Condition	Total Surveys Completed	Count	Percent by Condition
Semi-Control	2	15	24.1
	1	50	76.9
Negative Affect	2	16	29.9
	1	39	70.1
Social Normative	2	21	32.8
	1	43	67.2

For our analyses, we focused on Survey 1 and Survey 2, which were completed at baseline and after all of the email tips were sent. Survey 1 contained the Environmental Action Scale (EAS), mean = 32.300, SD = 12.143 (Alisat & Riemer, 2015), and a scale developed to measure engagement and intention based on the theory of planned behavior (Fielding et al., 2008). Survey 2 contained the post-version of the planned behavior scale. Across the conditions, the participants reported a mean pro-environmental behavioral intentions score of 25.5, SD of 4.68. There was no significant difference between conditions. Participants who were GAs reported a statistically significant higher level of behavioral intent than Non-GAs, $\alpha_{\text{Green Advisors}} = 4.64, p < 0.001$. When compared to the pre-intervention survey, participants reported lower pro-environmental behavioral intent in the post- intervention survey, $\beta_{\text{Behav Int Post}} = -0.755, p = 0.0457$.

Table 10. Mixed Effects Linear Model of Behavioral Intentions Pre and Post by Condition

	Estimate	Std.Error	t.value	p
(Intercept)	24.681	0.551	44.793	
Social Norm	0.904	0.746	1.211	0.226
Negative Affect	1.042	0.786	1.326	0.185
Behavioral Intent Post	-0.755	0.378	-1.998	0.046
Green Advisor	4.644	1.263	3.677	0.000

The second part of the environmental activism survey measured behavioral engagement. Across the conditions, the participants reported a mean pro-environmental behavioral engagement score of 24.421, SD of 4.038. There was no significant difference between conditions and between non-GAs and GAs. When compared to the pre-intervention survey, participants reported lower pro-environmental behavioral intent in the post- intervention survey, $\beta_{\text{Beh Eng Post}} = -1.813$ ($p < 0.001$).

Table 11. Mixed Effects Linear Model of Behavioral Engagement Pre and Post by Condition

	Estimate	Std.Error	t.value	<i>p</i>
(Intercept)	24.106	0.504	47.809	
Social Norm	0.224	0.665	0.336	0.737
Negative Affect	0.393	0.702	0.559	0.576
Behavioral Engagement Post	-1.813	0.424	-4.280	0.000
Green Advisor	1.154	1.122	1.029	0.303

We used Poisson regression to estimate the effect of condition (social norm, negative affect) on the count of plastic bag donated for recycling. As indicated in Table 10, while negative affect did not have a significant effect on plastic bag donation, the individuals in the social norm condition were less likely to donate plastic bags, $\alpha_{\text{Social Norm}} = .323$, $p < 0.001$. For the remaining regressions, we used the EAS as the measure of environmental attitudes. Environmental attitudes also did not have an effect on donation behavior, though, being a GA did show a more than 11 times in the likelihood of plastic bag donation, $\alpha_{\text{Green Advisor}} = 11.173$, $p < 0.001$.

Table 12. Poisson Regression Modeling Plastic Bag Recycled by Condition

	Estimate	Robust SE	LL	UL	<i>p</i>	
(Intercept)	0.552	0.506	0.091	3.336	0.122	
Social Norm	0.323	0.306	0.050	2.073	0.000	***
Negative Affect	0.000	0.000	0.000	0.000	0.983	
Environmental Attitudes	1.012	0.026	0.962	1.064	0.316	
Green Advisor	11.173	10.234	1.856	67.273	0.000	***

Our second behavior of interest was attendance of an environmentally focused summit run by the college. As indicated in Table 11, individuals who donated bags or who were GAs were more likely to attend the summit than non-donators or non-GAs. Estimates from logistic regression models showed that those who donated bags were 12 times more likely to attend the summit than the comparison group, $\alpha_{\text{Donated}} = 12.467$, $p = .023$. Individuals who were GAs were 14 times more likely to attend the summit than the comparison group, $\alpha_{\text{Green Advisor}} = 14.208$, $p = 0.048$, and as environmental attitudes increased, so did the likelihood of attending the summit, $\beta = 1.063$, $p = 0.011$.

Table 13. Logistic Regression Model of Summit attendance by Donation Behavior

	Estimate	Robust SE	LL	UL	<i>p</i>	
(Intercept)	0.003	0.003	0.000	0.020	0.000	***
Donated Bags	12.467	11.390	2.080	74.721	0.023	*
Green Advisor	14.208	15.772	1.613	125.163	0.048	*
Environmental Attitudes	1.063	0.024	1.016	1.112	0.011	*

Results of logistic regression models used to explore the effect of condition on the summit attendance are displayed in Table 12. There was no significant difference between the Social Norm, the Negative Affect and comparison group (which included individuals in the Semi-Control condition). We observed an increase likelihood of attending the summit by individuals who donated bags, $\alpha = 9.210$, $p = 0.059$, who were Green Advisors, $\alpha = 18.617$, $p <$

0.01, and as environmental attitudes increased, so did the likelihood of attendance, $\beta = 1.077$, $p = 0.025$.

Table 14. Logistic Regression Model of Summit Attendance by Condition

	Estimate	Robust SE	LL	UL	<i>p</i>	
(Intercept)	0.003	0.003	0.000	0.022	0.000	***
Social Norm	0.229	0.243	0.029	1.837	0.211	
Negative Affect	0.249	0.437	0.008	7.789	0.338	
Donated Bags	9.210	7.728	1.778	47.696	0.059	.
Green Advisor	18.617	20.710	2.104	164.753	0.007	**
Environmental Attitudes	1.077	0.024	1.032	1.124	0.025	**

Study 2

Study 2 is the analysis of the group level behaviors of the same field experiment in Study 1. Each building on campus was assigned to a condition and all of the residents of the building received the same email intervention. In Study 2, we plan to measure the effect of different messaging (social norm, negative affect, calculation based) on energy usage (kilowatt hour). Our hypothesis is the same as in Study 1, the students in the buildings in negative affect will show a greater initial decrease in energy consumption, while those in the buildings in the social norm condition will show greater sustained decrease in energy consumption.

Method

Participants

There are 18 residential buildings included in the study, housing 1402 students. With the addition of off-campus housing ($n = 78$), the total individuals reached by the study are 1480. Approximately 92 percent of the student body live within college-owned or college-affiliated

housing. Eight of the buildings were not included in the study because of inconsistent energy metering.

Procedure

The student resident halls were randomly assigned into three conditions: semi-control, negative affect and social norm. We weighted the randomization to ensure that the three conditions contained roughly equal students and roughly equally sized buildings. This resulted in 470 student residents in the Semi-Control condition, 499 in the Negative Affect condition, and 511 in the Social Norm condition. Students who lived in these resident halls were also assigned to the same condition. This allowed for all intervention communication to be contained within the walls of each resident hall, reducing the potential for communication contamination between residence halls. Table 15 shows the group level communication schedule.

Table 15. *Schedule of Student Interaction*

Week 5	Tip 1
Week 6	Tip 2
Week 7	Tip 3
Week 8	Spring Break
Week 9	Tip 4

Residence energy usage, reported in kilowatt hours (kWh) was recorded every 15 minutes in 10 of the 18 residence halls and was converted to daily kWh usage. For reference, one kWh is roughly equivalent to running 25 typical 40 watt compact florescent lamp (CFL) for 1 hour. Data for this study covered a period of nearly five months (January 17-May 11), which includes the entire Spring semester of the college. The five months were divided into three periods, pre-treatment, treatment, and post-treatment. Pre-treatment spanned from January 17, 2016 to February 15, 2016. The treatment period began with the first emailed tip on February 16, 2016 and ran until March 22, 2016. This period included spring break when students were

mostly absent from their residents. Since the kWh usage during this time period would not reflect the true usage of the students, March 7, 2016 – March 12, 2016 was removed from the data analysis. The data was collected by a Siemens Energy Management System.

Results

As shown in Figure 12, each of the 10 buildings reported a different average daily energy load and have different daily variances. This was the result of different levels of occupancy. We took different levels of occupancy into account when we randomized the conditions, before we had access to the consumption data.

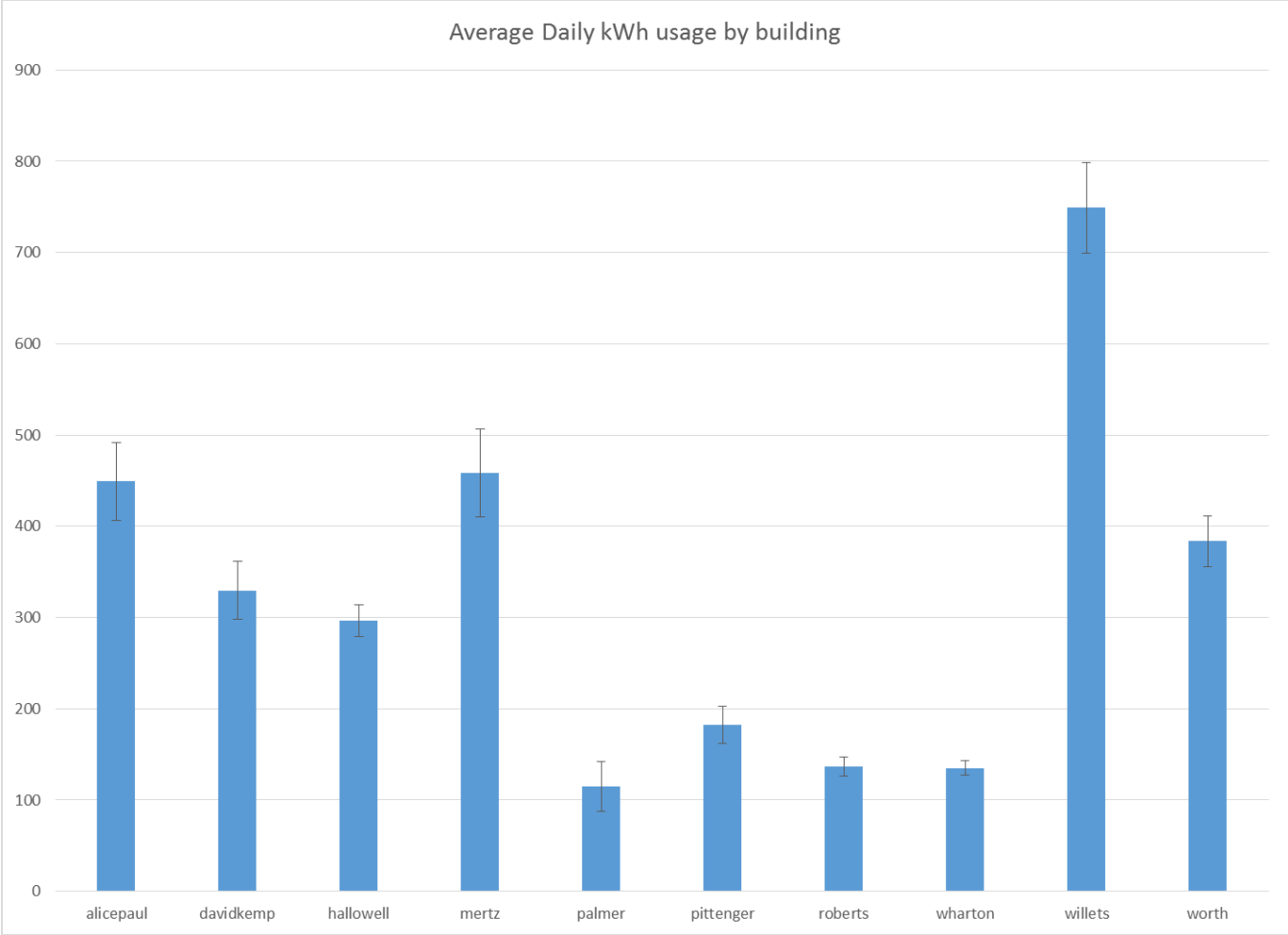


Figure 13. Average Daily kWh usage by building

Figure 13 shows the daily energy consumption by condition over the course of the study. In general, the buildings in the Negative Affect condition used the most energy, the buildings in the Social Norm condition used the least amount of energy, and the Control condition energy usage was between that of the two conditions.

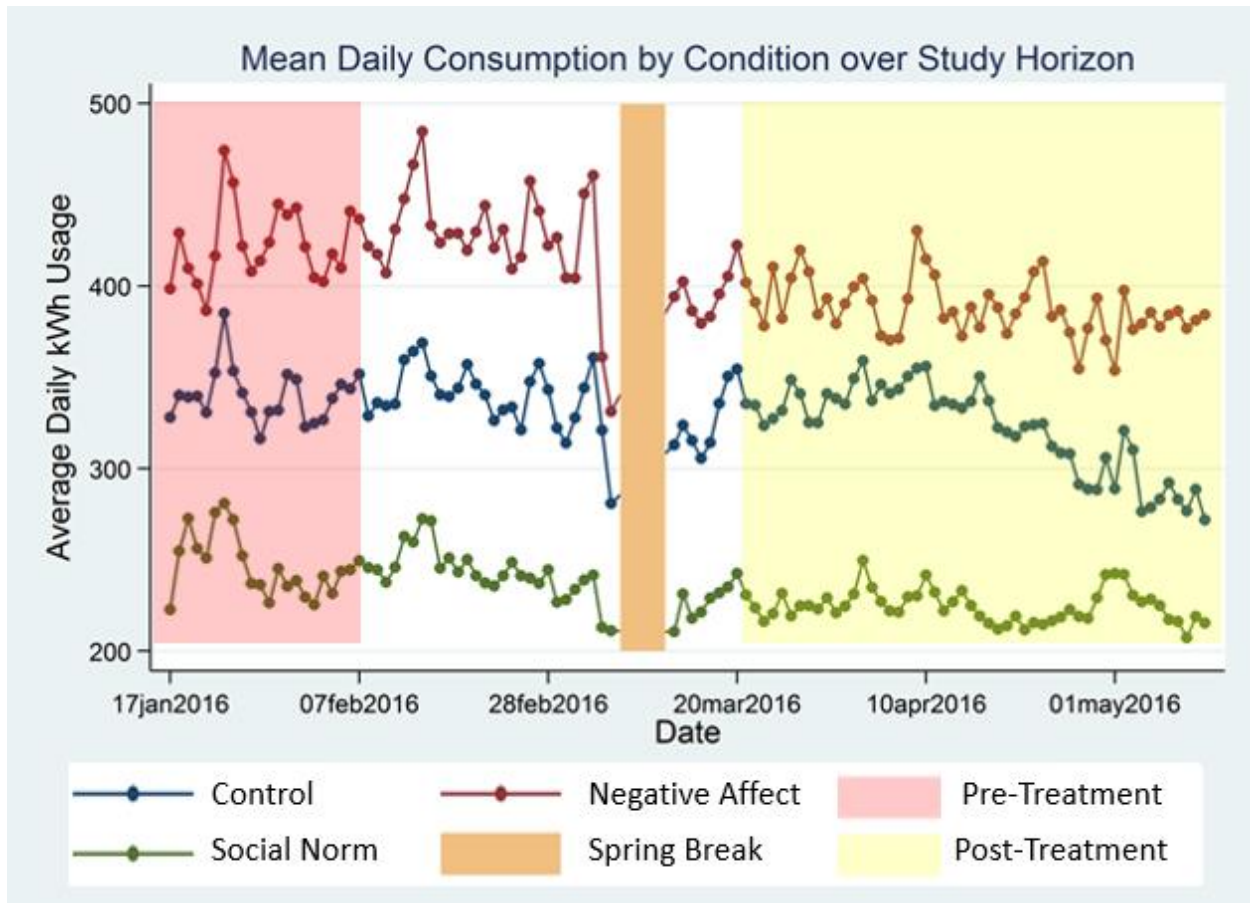


Figure 14. Mean Daily Consumption by Condition over study

The results of a mixed effect model looking at the effect of Condition on building level energy consumption are presented in Table 14. Because of the repeated measure nature of our outcome variable (kWh over a 5 month period) and because the buildings have vastly different means and variances, we decided to allow each building to have a random intercept. This allowed us to group each building consumption readings together, before separating them into the three conditions.

We also controlled for weekday/weekend behavioral differences. Since the college's classes were during the week, we anticipated that there would be two distinct patterns of energy consumption, weekday and weekend. During the week students were expected to be in class for

a large segments of the day and residence halls were expected to have lower energy consumption. During the weekend, we expected that the students might spend more of their time inside the dorm rooms and residence hall energy consumption would be higher. In order to control for these different usage patterns, we created a binary variable called Weekday where 0 represented the consumption during Saturday and Sunday, and 1 represented the consumption Monday through Friday. As expected, students used less energy during the week than the weekend, $\alpha_{\text{Weekday}} = -7.850, p < 0.001$.

As reported earlier, the buildings in the Social Norm condition generally had a higher energy load than the comparison group, $\alpha_{\text{Social Norm}} = 85.249$, and the buildings in the Negative Affect condition had a lower energy load than the comparison group, $\alpha_{\text{Negative Affect}} = -92.949$, but neither of these two conditions are significantly different than the comparison group, with $p = 0.595$ and $p = 0.562$ respectively.

In order to understand the size and longevity of our effect, we split the data into three time periods, a pre-treatment period (energy consumption before any emails were sent out), a treatment period (consumption during the emails), and a post-treatment period (consumption after the last email). This allowed us to compare the effect of condition both during and after our intervention as well as to a baseline. During the treatment time period and the post-treatment time period, energy consumption was significantly reduced across conditions, $\alpha_{\text{Treatment}} = -9.150, p = 0.016$, and $\alpha_{\text{Post Treatment}} = -20.374, p < 0.001$, respectively.

Table 16. Mixed Effect Linear Model of Energy Consumption by Condition

Fixed Effects				
	Estimate	Std Error	t value	p
(Intercept)	347.243	105.043	3.306	0.001
Social Norm	85.249	160.443	0.531	0.595
Negative Affect	-92.949	160.443	-0.579	0.562
Treatment	-9.150	3.785	-2.417	0.016
Post Treatment	-20.374	3.345	-6.091	0.000
Weekday	-7.850	1.931	-4.065	0.000
Social Norm : Treatment	-4.765	5.782	-0.824	0.410
Negative Affect : Treatment	-5.179	5.782	-0.896	0.370
Social Norm: Post Treatment	-18.555	5.109	-3.632	0.000
Negative Affect : Post Treatment	-3.804	5.109	-0.745	0.457

Random Effects		
Groups	Variance	Std Dev
Dorm Building (Intercept)	44100.6	210
Residual	845.2	29.07

ANOVA				
	Df	Sum Sq	Mean Sq	F value
Condition	2	850	425	0.5028
Treatment Period	2	146200	73100	86.4934
Weekday	1	13967	13967	16.5264
Condition : Treatment Period	4	15065	3766	4.4562

In order to explore the effect of condition during each of the treatment time period, we analyzed the interaction between each of the conditions and the treatment time period. The effect of Social Norm and the Negative Affect was a small, negative, non-significant additional decrease in energy consumption. In the post-treatment period, the consumption of the buildings in the Social Norm condition were significantly less than the energy consumption of the comparison group, $\alpha_{\text{Social Norm: Post Treatment}} = -18.555, p < 0.001$.

Besides the intervention, other external variables affected energy consumption in the residential buildings. Figure 14 shows the relationship between external air temperature and

energy consumption of the residential buildings. As the outdoor temperature increased, the energy consumed decreased. To control for this in our analyses, temperature data was downloaded from Weather Underground (weatherunderground.com) and using the mean daily temperature reported by Weather Underground, we calculated heating degree days (HDD) for each day in the data set.

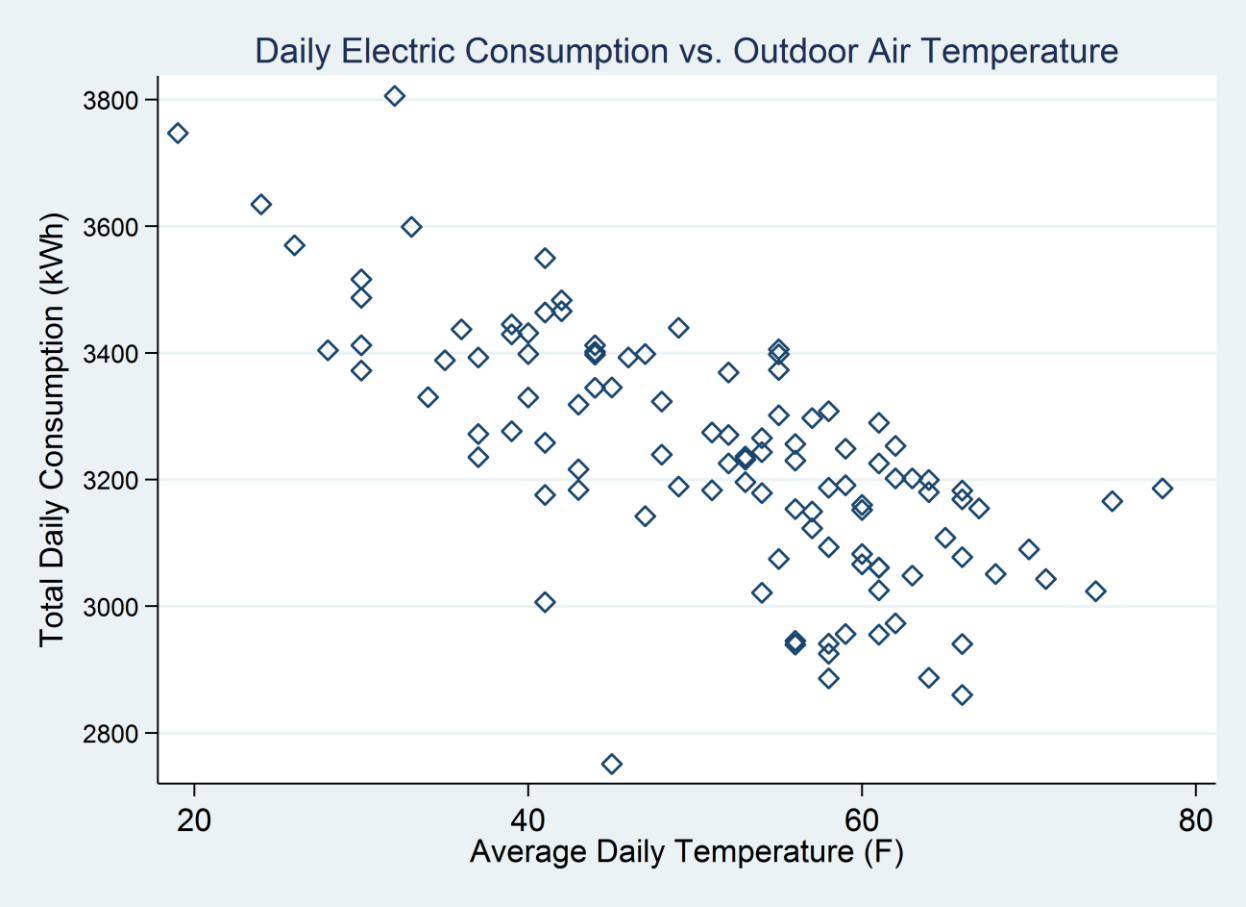


Figure 15. Consumption vs Outdoor Air Temperature

HDD was calculated as:

$$HDD = \begin{cases} 60 - \text{Mean Daily Temperature}, & \text{Mean Daily Temperature} \leq 60 \\ 0, & \text{Mean Daily Temperature} > 60 \end{cases}$$

The highest HDD was 46, which calculates to an external air temperature of 14°F.

The results of a mixed effect model looking at the effect of condition on building level energy consumption, controlling for weekday and HDD, are presented in Table 15. As HDD increases, building energy consumption increases; as it gets colder, kWh increase, $\beta_{\text{HDD}} = 1.002$, $p < 0.001$. With HDD in the model, there was no significant difference during the treatment and post-treatment period from the comparison group, but the interaction of Social Norms and the post-treatment period showed a significant decrease in energy consumption, $\alpha_{\text{Social Norm: Post Treatment}} = 18.555$, $p = < 0.001$.

Table 17. Mixed Effect Linear Model of Energy Consumption by Condition Controlling for Temperature

Fixed Effects				
	Estimate	Std Error	t value	<i>p</i>
(Intercept)	318.582	105.096	3.031	0.002
Social Norm	85.249	160.441	0.531	0.595
Negative Affect	-92.949	160.441	-0.579	0.562
Treatment	2.925	3.935	0.743	0.457
Post Treatment	0.669	4.083	0.164	0.870
Weekday	-5.688	1.888	-3.012	0.003
HDD	1.002	0.118	8.473	0.000
Social Norm : Treatment	-4.765	5.602	-0.851	0.395
Negative Affect : Treatment	-5.179	5.602	-0.924	0.355
Social Norm: Post Treatment	-18.555	4.950	-3.749	0.000
Negative Affect : Post Treatment	-3.804	4.950	-0.769	0.442

Random Effects		
Groups	Variance	Std Dev
Dorm Building (Intercept)	44101.3	210
Residual	793.3	28.17

ANOVA				
	Df	Sum Sq	Mean Sq	F value
Condition	2	798	399	0.5028
Treatment Period	2	146200	73100	92.1466
Weekday	1	7198	7198	9.0729
HDD	1	63717	63717	80.3191
Condition : Treatment Period	4	15065	3766	4.7474

In addition to external air temperature, daylight could also have had an effect on energy consumption. People tend to use less electricity when there is more natural sunlight (i.e., using natural light to illuminate a room instead of electric light). Because the study started in January, where the amount of daylight per day can be as little as nine hours and a half hours, and ended in May, where the amount of daylight is almost 15 hours, we added a variable with the number of daylight hours for each day in the data set. This data was downloaded from the Astronomical

Applications Department of the U.S. Naval Observatory (Astronomical Applications Department of the U.S. Naval Observatory, 2011).

In Table 16 are the results of a mixed effect model looking at the effect of Condition on building level energy consumption. The amount of daylight had a significant effect on energy consumption, with a reduction of 11.421 kWh a month for every hour increase in daylight, $\alpha_{\text{Daylight}} = -11.421, p < .001$. The external air temperature also had a significant effect, with each HDD increase resulting in 0.855 kWh increase, $p < 0.001$. We also detected a significant decrease of energy consumption during the week, $\alpha_{\text{Weekday}} = -6.650, p < 0.001$. We controlled for the effects of daylight, external air temperature and weekday on energy consumption. Generally, during treatment and post-treatment the energy consumption increased, $\alpha_{\text{Treatment}} = 15.470, p < 0.001$ and $\alpha_{\text{Post Treatment}} = 33.574, p < 0.001$ respectively.

Table 18. Mixed Effect Linear Model of Energy Consumption by Condition Controlling for Temperature and Daylight

Fixed Effects				
	Estimate	Std Error	t value	p
(Intercept)	439.299	106.602	4.121	0.000
Social Norm	85.249	160.439	0.531	0.595
Negative Affect	-92.949	160.439	-0.579	0.562
Treatment	15.470	4.280	3.614	0.000
Post Treatment	33.574	6.306	5.325	0.000
Daylight	-11.421	1.692	-6.752	0.000
HDD	0.855	0.118	7.252	0.000
Weekday	-6.650	1.856	-3.583	0.000
Social Norm : Treatment	-4.765	5.490	-0.868	0.385
Negative Affect : Treatment	-5.179	5.490	-0.943	0.346
Social Norm: Post Treatment	-18.555	4.851	-3.825	0.000
Negative Affect : Post Treatment	-3.804	4.851	-0.784	0.433

Random Effects		
Groups	Variance	Std Dev
Dorm Buildings (Intercept)	44101.6	210
Residual	761.9	27.6

ANOVA				
	Df	Sum Sq	Mean Sq	F value
Condition	2	766	383	0.5028
Treatment Period	2	146200	73100	95.9441
Daylight	1	48768	48768	64.0083
HDD	1	47102	47102	61.8211
Weekday	1	9781	9781	12.8372
Condition : Treatment Period	4	15065	3766	4.9431

When looking at the interaction between the Social Norm condition and the time period of treatment, we observed a non-statistically significant reduction of energy consumption of -4.765. The Negative Affect interaction with time of treatment was also a non-significant reduction of energy consumption. While the probability of achieving these numbers by chance are high (about 30%), the small decreases indicate that the effect of treatment alone, an increase

of 15.470, was probably the result of an large increase in energy usage among the buildings in the control condition compared to the small decrease in the Social Norm and the Negative Affect conditions. During the post-treatment time period, the buildings in the Negative Affect condition showed a small, but non-statistically significant reduction in energy consumption, $\alpha_{\text{Negative Affect : Post Treatment}} = -3.804, p = .433$. While the interactions during the treatment time period were non-significant, the buildings in the Social Norm condition showed a considerable decrease in energy consumption during the post-treatment time period, $\alpha_{\text{Social Norm : Post Treatment}} = 18.555, p < 0.001$.

Discussion

We successfully demonstrated that certain choice architecture tools, specifically social norms, have a greater likelihood to produce positive spillover behavior than negative affect or simple, factual information alone. Even though all of the conditions led to an initial decrease in energy usage, only effect of social norm was detectable after controlling for temperature and daylight and was sustained post intervention.

While use of social norm interventions for persistent energy reduction is not novel (see Allcott and Rogers (2014) and Frey and Rogers (2014)), this research addresses a crucial, inseparable component of the previous research, financial incentives. In previous research with energy providers, the co-benefit of energy reduction was financial savings. Even though the monetary savings amounts were not large, customers who achieved higher levels of energy reduction also paid less on their energy bills. Our research demonstrates that social norm interventions influenced sustained behavioral change even without the financial benefit. Students engaged in energy savings behavior without receiving a reduction in their room and board fees or any promise of future monetary savings. All of the email tips focused solely on environmental reason for energy reduction. While the five percent decrease in energy

consumption during the post intervention period was smaller than the amount saved by in Allcott and Rogers (2014)'s study, with over 3,000 four year colleges in the United States (National Center for Education Statistics, 2016), the combined savings would be substantial. In addition to residential halls at colleges, many individuals live in dwellings where they are not financially responsible for certain amenities (e.g., New York City apartment buildings do not bill for heat and water , certain amenities are covered by financial assistance in low income housing). Additionally, many individuals work in places where energy reduction behaviors (e.g., turning of lights when leaving a meeting room, using the stairs instead of the elevator) could lead to a reduction in business overhead cost, but employees would not receive any financial benefit from engaging in these behaviors.

In addition to the lacking monetary rewards, our study also did not use feedback, another effect increasing component found in other energy reduction interventions. Energy reduction interventions usually include monthly bills which compare residents' usage with others like them in their neighborhood. In addition to the comparison with others, month-to-month and year-to-year comparisons for the resident themselves are included in each bill. This information provides feedback to individuals that helps them to monitor their usage and potentially adjust energy usage behaviors. Students in the dorms had no way of knowing what the effect of their efforts were, or whether others were joining them to collectively make a difference. We decided to not include a competition/comparison between dorms or conditions so that we could isolate the effect of condition alone. Future interventions could test the use of comparisons and individual-level feedback to increase the effect.

While the individual level data did not show spillover effects, we feel that failure to observe an individual level effect was due to an underpowered experiment. This study was

originally designed to be run at multiple locations with four times the potential individual level data. With a larger sample size, we may have had greater success in detecting an effect. In addition to being underpowered, because of time and various constraints, we were unable to have more than a single option for spillover behavior. Our original study had higher student engagement, including posters, video message boards to increase saliency to the students. We also planned more measurable spillover behaviors than just the summit attendance. We intended to measure environmental volunteerism, pledge signing, and club enrollment. Future field experiments should include multiple spillover measures to capture more of the available students and increase the signal to detect a difference.

In the group level data, we show sustained behavior change, decrease in energy consumption by those in the social norm condition. While we performed a weighted randomization of buildings into the three conditions, there is evidence, that the three conditions were in fact different. Figure 15 shows three lines that look to be different throughout the entire process. This difference could be the result of a failure of random assignment, where buildings with similar students were randomly put together causing one condition to have a greater or lesser reaction to the intervention than the other conditions. Another interpretation is that not every building responded in the same fashion to the intervention. Some buildings may have shown a decrease in usage, while other show a flat or an increase in usage in the same condition. When combining them into conditions, some buildings will have a larger influence than others on the reported condition consumption. In future studies, we will acquire greater historic information to better calibrate the weighted randomization to ensure that all of the conditions are starting at the same level before the intervention as well as have more data to reduce the variance within condition.

As we explore each choice architecture tool, we uncover more about why they work, what the boundary conditions are, and how to apply them more effectively. Research into the downstream effects of choice architecture tools will lead to more effective interventions, specifically in domains that require greater continued engagement (e.g., health, finance, the environment). The first step will be to isolate the effect of each tool separately. Once we develop a better understanding of mechanism and direction of spillover for each tool, the next step should focus on ways to attain the level of behavior change associated with tools like negative affect, without individuals partaking in negative spillover behavior. Even if negative spillover behavior is associated with tools such as negative affect, we should not dismiss negative affect as an effective means to achieve behavioral change. Instead, future research could investigate the use of multiple levels of engagement in complex scenarios where negative spillover is likely to be a concern. For example, the first level might be a strong negative default to achieve the initial high levels of behavioral change and the second level might be to use social norms to further engage the individual and encourage positive spillover behavior. This multilevel engagement might help to achieve initial behaviors and also alleviate the negative spillover effect.

IV. General Discussion

In the series of studies above, we have examined the cognitive mechanisms behind risky choice framing and the effect of choice architecture tools on initial and spillover behavior. In Chapter 1, we found that the attractiveness of the outcomes can lead to shifts in risky choice behavior. In Chapter 2, we found that choice architecture, specifically default settings, can lead to behavioral spillover. And in Chapter 3, we tested the effects of choice architecture on spillover in a field experiment and found that social norm messaging lead to sustained behavior change. Together these studies expand the body of literature that demonstrates an effect of choice architecture tools on positive and negative spillover.

People make several decisions each day and most of the time they are unaware of how they are being influenced. While doctors are trained to present medical options in both gain and loss framing, not everyone has the same motivation. With a better understanding of the mechanisms behind risky choice framing, we can develop tools for the decision maker to help mitigate the effect of the frame. To realize that an individual's current state influences the attractiveness of the outcomes. For individuals who are being charged with a crime, the attractiveness of a shorter jail sentence (plea bargain) changes based on whether you could afford bail (Bibas, 2004). Individuals who cannot afford or are not granted bail are looking at the certain gain of getting out of prison faster as attractive, while those who are granted bail view the same plea as repulsive, a certain loss of going to prison at all. The larger question is, are prosecutors aware of this perceptual difference, and do they use it to their advantage? What steps can be taken to mitigate of framing in scenarios where the decision making is not presented with the information equally?

In addition to risky choice framing, I have also contributed to the understanding how other choice architecture tools influences not only initial behavior, but also subsequent spillover behaviors. As these tools become more popular, and as policy makers begin to use choice architecture as the main, go to tool to make us safer, healthier, more financially secure and more environmentally conscious, it is evidently clear that we need to understand the long term ramifications of these tools.

Given the political climate we live in, the direction of policy and the popularity of nudges, and monetary limits for incentive interventions, behavior interventions may be the primary means of encouraging behavior change, especially in often politicized areas like climate change. Considerable focus has been placed on the potential negatives surrounding the removal of incentives on behavior change, a similar focus is required for choice architecture.

Since behavioral spillover is a relatively new and still growing psychological concept, we believe this collection of studies will help to define behavioral spillover and direct future research. Spillover is currently defined as the effect of initial behavior on subsequent behavior. Our goal as psychologists is to create interventions that not only increase the initial behavior, but also increase the recipient's openness to engaging in subsequent behaviors. In our studies, we set an intervention to increase a pro-environmental behavior. Our overall goal was to make an impact to address climate change. In Chapter 2, we are successful in increasing pro-environmental behavior, but we fail to achieve our ultimate goal of a positive overall effect on climate change. In Chapter 2, Study 2, about 80 percent of our sample did not do the initial behavior. This result by itself is acceptable. Rarely does an intervention reach all of the intended targets, but the issue is 80 percent of the people were also less likely to do the second behavior than those in the comparison group. The group without any intervention at all, showed

more interest in the subsequent decisions than the group we targeted with the intervention. In the end, the 80 percent does more damage to the environment in the long term when compared to the benefit of those who were positively influenced by the intervention. Use of default setting may have impact on negative spillover, and future studies should examine this further or should be considered when applying this tool to this outcome.

Some questions have been raised about the way to measure spillover. Currently there are three popular methods to measure behavioral spillover; 1) ignore individuals who do not do the first behavior and only measure the second behavior of those who completed the first behavior, 2) measure the interaction between the first behavior and the second behavior, and 3) measure the effect of the intervention on the second behavior (Truelove, 2017). These three approaches signify three different definitions of spillover and three different causal questions. In the above studies, we successfully measure spillover using these three methods. In Chapter 2, Study 2, we measure the interaction between the first behavior and the second behavior. We then show the effect of only those who performed the first behavior. In Chapter 2, Study 3, we show the general effect of the intervention on the second behavior.

The first method, which focuses on the individuals who completed the first behavior and removes the individuals who did not complete the first behavior from the analyses, has a very strict interpretation of spillover. When analyzing only the second (spillover) behavior of those who completed the first behavior, we get an understanding of the difference in spillover behavior between the conditions. A limitation of this approach is that without the other two possible outcomes (failed to do the first behavior and completed the second behavior and failed to do both the first and second behaviors), we have no information on the baseline attractiveness of the

second behavior, which could lead to differential behavior between the first and the second behavior.

The second approach is the interaction approach. When we measure the interaction between condition and first behavior, we have a better understanding what happens with the intervention works and when it does not work. When the first behavior is binary, the interaction allows us to contrast between all of the potential outcomes, which is just as important when attempting to take into account the overall benefit of the intervention. In our case, while we observed a 10% increase in the initial behavior (from 17% to 28%), we saw a 25% decrease in the subsequent behavior by those who overcame the intervention. This decrease could wipe out the initial increase depending on the effectiveness of each behavior. Having the interaction in the model allows us to know the effect on people who overcame the intervention and what they did next. Allows us to know if there were any reactance and what is the effect. These factors have to be known, and should go into the overall calculation of cost and benefits of the intervention to ensure the benefit of the first behavior is large enough to compensate for loss accumulated by the reactance to the intervention, or to plan a different, more effective intervention.

While the interaction is best for when the first behavior is binary, it is less informative when the first behavior is continuous. An interaction with a continuous first behavior allows us to estimate the spillover effect given the size of the effect of condition on the first behavior. Since we are not necessarily focused on the spillover effect based on the size of the first behavior, an interaction is not needed. A model that estimates the effect of condition, controlling for the first behavior, gives us the global effect of the intervention on the secondary, spillover behavior.

Taking into account the methods of measuring spillover, I believe the greater goal of the intervention needs to be taking into account. We state that positive spillover is the congruent subsequent behavior after an initial behavior, while negative spillover is the incongruent subsequent behavior after an initial behavior. In order for this definition to fit the goal of the intervention, I suggest extending the definition. Positive spillover occurs when the initial and the subsequent behaviors are congruent with the goals of the intervention. Negative spillover occurs when the initial behavior is congruent with the intervention, but the subsequent behavior is incongruent with the goals of the intervention. Reactance, a negative behavior but not spillover, occurs when both the first and second behavior are incongruent with the goals of the intervention. For example, I create an intervention to encourage pro-environmental behavior, eating less meat. My immediate goal is to lower meat intake, but my overall goal is to promote pro-environmental behavior. Eating less meat, the first behavior, and then buying local produce would be an example of positive spillover. I set the direction with my intervention, and all of the behaviors are going in the same direction. While not being influenced by the intervention is normal, the combination of avoiding the intervention and doing less future pro-environmental actions in the future is reactance. Both the first and the second behavior are incongruent with the intentions of the interaction. Negative spillover occurs when the first behavior is the intended behavior of the interaction, but the subsequent behaviors are not. This helps to highlight the difference between behavior spillover and behavioral consistency and extended definition of spillover research takes the perspective of the interventionist. Without this distinction behavioral consistency in the negative direction would fall under positive spillover since the second behavior is congruent with the first, even though the behaviors are the opposite of the intervention. With this in mind, interventions should be designed to minimize consistency from

reactance so that individuals who avoid the intervention behavior like individuals who received no intervention at all and maximize consistency with the positive initial behavior to lead to positive spillover behavior.

The goal moving forward should be to find ways to strengthen our interventions and capture more of the individuals who want to change, but have a hard time overcoming the hurdles to behavioral change. More work needs to be done focusing on the mechanism of choice architecture tools and their long term effects. One avenue is to look at choice architecture and habit formation. Habits are difficult to create and difficult to extinguish (Lally, van Jaarsveld, Potts, & Wardle, 2010), but might be the step in between single behavior change and seeking out other parallel behaviors in the same domain. Habit is defined as the automatic process between a situation and a behavior or action (Verplanken, 2006). This automatic process is usually the result of repetition of the behavior following the situation to the point where the individual is unaware of the connection, or uses considerably less effort to come to perform the behavior (Bargh, 1994). Instead of changing a single behavior, future research should explore the use of choice architecture to encourage a long term habit (Forster, Crookes, & Weber, 2016). Once new habits form, individuals will partake in the behavior with little prompting or effort. As the strength of the habit increases, usage of tools like social norms to increase identity should lead to positive spillover effects. By combining habit research and spillover research, we can achieve sustained and increased behavior change.

One of the benefits of conducting research using different methods and different populations is the ability to better understand why some interventions work in some contexts but fail in other contexts. We saw different results for social norm and negative affect in Chapter 2 than we observed in Chapter 3. In Chapter 2, we observed a nonsignificant effect of social norm

and negative affect on both the initial and subsequent behavior. In Chapter 3, we observe a significant effect of social norm on sustained behavior. As stated in Chapter 2, the lack of effect could be linked to the vignette and the hypothetical situation not being salient enough to create a sense of identity in the social norm condition, or the sense of emotional urgency in the negative affect condition. While in Chapter 3, identity and group membership was salient, leading to a more effective intervention. Even as we push to expand the understanding of choice architecture, we also acknowledge limitations in the above research. Chapters 1 and 2 include lab studies with stylized vignettes hypothetical outcomes mixed in with outcomes that effect the decision making. This served the purpose of strict laboratory control in an effort to isolate a previously undefined effect. Future studies should include a manipulation check to better understand the how strong the intervention needs to be to observe and effect. Future studies should also explore ways to make all of the decisions impactful to the decision maker. For example, instead of a vignette about a hypothetical apartment amenities, maybe work can be done with the healthiest lunch options being preselected and measuring the effect on subsequent healthy behaviors. This would allow us to understand the effect when all of the behaviors have a legitimate consequence to the decision maker.

Because of the relative small effect size of any one spillover behavior, additional measures of behavioral spillover are needed to understand the full scope of the subsequent behaviors. If we measure many subsequent behaviors, possibly by using smartphones and connected devices, we could potentially understand the magnitude of spillover behavior (spillover happens, but some for some people more than others), as well how long before the intervention no longer effects the subsequent behaviors.

While the field experiment addressed many of the limitations of lab and online research, Chapter 3 also had limitations, including individual engagement, sample size. The individual level effect in Chapter 3 suffered from a small sample size, and low engagement. Emails are an initial step to reach participants, but more needs to be done or additional lines of communication may be needed. In the future, posters, location-wide messaging to reiterate the message could help to reach a larger proportion of the student body and increase the sample size. The building-level analysis in Chapter 3 also had a small sample size. Replication of this study/future research could be completed at larger colleges or use multiple locations to increase both the building-level and individual-level sample sizes.

The above research is a step towards a better understanding of how to approach complicated long term problems with choice architecture tools. Moving research from the one-and-done approach to a long term focus will allow for better, more directed interventions in the areas of health, finance and the environment. While it requires significant effort to change and sustain behavior, with the right tools used in the correct manor, individuals, policy makers and companies will be able to avoid negative behavioral spillover, and hopefully, encourage positive behavioral spillover.

V. Appendices

Appendix A – Spillover Intent

Please indicate how often you intend to perform the following behaviors over the next month:

	Never	Very infrequently	Once in a while	Sometimes	Often	All the time
Turn off lights whenever leaving a room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Take showers that are 5 minutes or less	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Use public transportation or carpool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unplug appliances and chargers (e.g., TV, cell phone, computer) at night	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Never	Very infrequently	Once in a while	Sometimes	Often	All the time
Buy green products instead of regular products (e.g., dishwashing detergent), even though they cost more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Write letters, email, phone or otherwise contact elected official to urge them to take action on environmental issues (e.g., climate change, air pollution)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Go Paperless (electronic bills instead of mailed bills)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please indicate how often you intend to perform the following behaviors over the next year:

	Never	Very infrequently	Once in a while	Sometimes	Often	All the time
Plant a Tree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Donate to charity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Purchase a carbon offset for air travel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support locally grown produce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research smart technology and energy efficient devices when replacing electronics and appliances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix B – Spillover behavior, information seeking

Below, we have provided you with some links to more information about ways to get involved in environmental issues. Feel free to click on as many of the links below that sound interesting to you: the link will open the website in a new window, and you can return back to this window to complete the task whenever you are ready.

[Meatless Mondays](#) - Learn how reducing meat intake decreases greenhouse gas emissions, including Carbon Dioxide and Methane gas.

[Sign a Petition](#) - Add your name to a petition that calls for elected representatives to lower our negative contribution to climate change.

[Buy Local Food](#) - When the source of your food is closer to you, it requires less energy to refrigerate and transport.

[Get emails to help remind you](#) - Email reminders and tips to help you become more environmentally conscious.

[Drive more efficiently](#) - We know you have to drive, learn how to make your commute more environmentally friendly.

[Email Your Representative](#) - Your representatives are your voice in the government. Let them know that you want them to advocate for positive environmental policies.

Appendix C – Apartment Amenities

Opt-Out

Suppose you are moving into a new apartment complex. This complex is one of the most attractive complexes at its price point. The landlord of your apartment complex has decided that all of the apartments by default will include a number of green amenities, listed below.

These green amenities will be included in your rent. However, if you would like any of these green amenities NOT to be installed, the landlord will deduct the cost of that amenity from your monthly rent (you will pay between \$2 and \$10 less per month for each amenity you omit). If you choose to omit a premium amenity, you will receive the standard version of that amenity rather than the green upgraded version.

You can therefore keep all of the green amenities that are included in your rent, or choose to receive the standard rather than green version of some or all of the amenities and pay a reduced amount each month.

Here are the green amenities:

- Energy-star furnace & air conditioner
- Tankless water-heater
- Programmable thermostat
- Storm windows & doors
- Airflow-adjusting ceiling fans
- UV filter film on windows
- Energy-efficient dishwasher & refrigerator
- Compact Florescent (CFL) light bulbs
- Energy-efficient washer & dryer
- Dimmer switches for indoor lighting
- Low-flow toilets
- Solar-powered outdoor lighting
- Low-flow faucets & shower heads
- Motion sensors for outdoor lighting

Here is the list of green amenities again. Please uncheck the box in front of any amenity that you would like to be standard rather than green. (If you uncheck a box you will receive the standard rather than green version of that amenity and you will pay between \$2 and \$10 less per month).

- | | |
|---|---|
| <input type="checkbox"/> Energy-star furnace & air conditioner | <input type="checkbox"/> Tankless water-heater |
| <input type="checkbox"/> Programmable thermostat | <input type="checkbox"/> Storm windows & doors |
| <input type="checkbox"/> Airflow-adjusting ceiling fans | <input type="checkbox"/> UV filter on windows |
| <input type="checkbox"/> Energy-efficient dishwasher & refrigerator | <input type="checkbox"/> Compact Florescent (CFL) light bulbs |
| <input type="checkbox"/> Energy-efficient washer & dryer | <input type="checkbox"/> Dimmer switches for indoor lighting |
| <input type="checkbox"/> Low-flow toilets | <input type="checkbox"/> Solar-powered outdoor lighting |
| <input type="checkbox"/> Low-flow faucets & shower heads | <input type="checkbox"/> Motion sensors for outdoor lighting |

Opt-In

Suppose you are moving into a new apartment complex. This complex is one of the most attractive complexes at its price point. The landlord of your apartment complex has decided that all of the apartments by option can include a number of green amenities, listed below.

These green amenities are NOT included in the standard rent. However, if you would like any of these green amenities to be installed, the landlord will add a small amount (between \$2 and \$10, depending on the item) to your monthly rent for each of the amenities you choose to add.

You can therefore add all of the green amenities, or choose to receive the standard rather than green version of some or all of the amenities and pay the standard amount each month.

Here are the green amenities:

- Energy-star furnace & air conditioner
- Tankless water-heater
- Programmable thermostat
- Storm windows & doors
- Airflow-adjusting ceiling fans
- UV filter film on windows
- Energy-efficient dishwasher & refrigerator
- Compact Florescent (CFL) light bulbs
- Energy-efficient washer & dryer
- Dimmer switches for indoor lighting
- Low-flow toilets
- Solar-powered outdoor lighting
- Low-flow faucets & shower heads
- Motion sensors for outdoor lighting

Here is the list of green amenities again. Please check the box in front of any amenity that you would like to be green rather than standard. (If you leave a box unchecked you will receive the standard rather than green version of that amenity and you will pay between \$2 and \$10 less per month).

- | | |
|---|---|
| <input type="checkbox"/> Energy-star furnace & air conditioner | <input type="checkbox"/> Tankless water-heater |
| <input type="checkbox"/> Programmable thermostat | <input type="checkbox"/> Storm windows & doors |
| <input type="checkbox"/> Airflow-adjusting ceiling fans | <input type="checkbox"/> UV filter on windows |
| <input type="checkbox"/> Energy-efficient dishwasher & refrigerator | <input type="checkbox"/> Compact Florescent (CFL) light bulbs |
| <input type="checkbox"/> Energy-efficient washer & dryer | <input type="checkbox"/> Dimmer switches for indoor lighting |
| <input type="checkbox"/> Low-flow toilets | <input type="checkbox"/> Solar-powered outdoor lighting |
| <input type="checkbox"/> Low-flow faucets & shower heads | <input type="checkbox"/> Motion sensors for outdoor lighting |

Social Norm

Suppose you are moving into a new apartment complex. This complex is one of the most attractive complexes at its price point. The landlord of your apartment complex has informed you that 76% of the tenants have chosen all of the green amenities listed below.

Green amenities are NOT included in the standard rent. However, if you would like any of these green amenities to be installed, the landlord will add a small amount (between \$2 and \$10, depending on the item) to your monthly rent for each of the amenities you choose to add.

You can therefore add all of the green amenities, or choose to receive the standard rather than green version of some or all of the amenities and pay the standard amount each month.

Here are the green amenities:

- Energy-star furnace & air conditioner
- Tankless water-heater
- Programmable thermostat
- Storm windows & doors
- Airflow-adjusting ceiling fans
- UV filter film on windows
- Energy-efficient dishwasher & refrigerator
- Compact Florescent (CFL) light bulbs
- Energy-efficient washer & dryer
- Dimmer switches for indoor lighting
- Low-flow toilets
- Solar-powered outdoor lighting
- Low-flow faucets & shower heads
- Motion sensors for outdoor lighting

Here is the list of green amenities again. Please check the box in front of any amenity that you would like to green instead of standard. (If you check a box you will receive the green instead of the standard version of that amenity and you will pay between \$2 and \$10 more per month).

- | | |
|---|---|
| <input type="checkbox"/> Energy-star furnace & air conditioner | <input type="checkbox"/> Tankless water-heater |
| <input type="checkbox"/> Programmable thermostat | <input type="checkbox"/> Storm windows & doors |
| <input type="checkbox"/> Airflow-adjusting ceiling fans | <input type="checkbox"/> UV filter on windows |
| <input type="checkbox"/> Energy-efficient dishwasher & refrigerator | <input type="checkbox"/> Compact Florescent (CFL) light bulbs |
| <input type="checkbox"/> Energy-efficient washer & dryer | <input type="checkbox"/> Dimmer switches for indoor lighting |
| <input type="checkbox"/> Low-flow toilets | <input type="checkbox"/> Solar-powered outdoor lighting |
| <input type="checkbox"/> Low-flow faucets & shower heads | <input type="checkbox"/> Motion sensors for outdoor lighting |

Negative Affect

Suppose you are moving into a new apartment complex. This complex is one of the most attractive complexes at its price point. The landlord of your apartment complex has informed you that each year, you produce about 2.8 metric tons of carbon emissions, equivalent to about 3,000 lbs of burned coal. By not choosing the energy efficient appliances, we estimate that you will use between 5 and 10 percent more than your neighbors.

Green amenities are NOT included in the standard rent. However, if you would like any of these green amenities to be installed, the landlord will add a small amount (between \$2 and \$10, depending on the item) to your monthly rent for each of the amenities you choose to add.

Here are the green amenities:

- Energy-star furnace & air conditioner
- Tankless water-heater
- Programmable thermostat
- Storm windows & doors
- Airflow-adjusting ceiling fans
- UV filter film on windows
- Energy-efficient dishwasher & refrigerator
- Compact Florescent (CFL) light bulbs
- Energy-efficient washer & dryer
- Dimmer switches for indoor lighting
- Low-flow toilets
- Solar-powered outdoor lighting
- Low-flow faucets & shower heads
- Motion sensors for outdoor lighting

Here is the list of green amenities again. Please check the box in front of any amenity that you would like to green instead of standard. (If you check a box you will receive the green instead of the standard version of that amenity and you will pay between \$2 and \$10 more per month).

- | | |
|---|---|
| <input type="checkbox"/> Energy-star furnace & air conditioner | <input type="checkbox"/> Tankless water-heater |
| <input type="checkbox"/> Programmable thermostat | <input type="checkbox"/> Storm windows & doors |
| <input type="checkbox"/> Airflow-adjusting ceiling fans | <input type="checkbox"/> UV filter on windows |
| <input type="checkbox"/> Energy-efficient dishwasher & refrigerator | <input type="checkbox"/> Compact Florescent (CFL) light bulbs |
| <input type="checkbox"/> Energy-efficient washer & dryer | <input type="checkbox"/> Dimmer switches for indoor lighting |
| <input type="checkbox"/> Low-flow toilets | <input type="checkbox"/> Solar-powered outdoor lighting |
| <input type="checkbox"/> Low-flow faucets & shower heads | <input type="checkbox"/> Motion sensors for outdoor lighting |

Appendix D - Email intervention

Social Normative

Email 1

Dear [Student]:

The [REDACTED] community is looking for ways to reduce energy usage and improve waste practices!

The College signed the American College & University President's Climate Commitment in 2010 to move the institution toward carbon neutrality by 2035. Your peers have already taken action and [REDACTED] has implemented many new initiatives for reducing electricity and water usage and increasing recycling.

Here are some ways to continue to increase sustainability on campus. You'll receive more tips over the next three weeks.



Energy Tip of the week:

Remember to turn off the lights whenever you leave your room, the lounge or any other common areas. Every minute counts.

Waste Tip of the week:

Use reusable bottles and containers to reduce waste. Put your reusable container with your bag to remind you to take it in the morning

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at [sustainability@\[REDACTED\].edu](mailto:sustainability@[REDACTED].edu).

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 2

Dear [Student]:

Your small changes can lead to big rewards, especially when done with your peers.



Energy Tip of the week:

Take the stairs as often as you are able. This will limit elevator usage, a major contributor to dorm electricity usage.

Waste Tip of the week:

In addition to printing double-sided, print two pages per side to save paper and weight in your bag. If you have pages with unused sides, save them and use them as scratch paper.

To help you dispose of tricky items, you will receive a brown bag that you can use to collect unwanted plastic bags. We will gather your plastic bag collections in about 10 days. Please write your Swat username on the brown bag and a Yes/No answer to the following question: Was this service useful?

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at [sustainability@\[REDACTED\].edu](mailto:sustainability@[REDACTED].edu).

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 3

Dear [Student]:

An average student produces around 30 pounds of waste a week, and approximately a third of that waste can be recycled. [REDACTED] students have already started to reduce their amount of waste. Below are ways to join them.



Energy Tip of the week:

Wash laundry only when you have a full load in order to save both energy and water. To energize your savings, wash your laundry using the cold water cycle.

Waste Tip of the week:

Bring your own reusable when shopping at Target, Co-Op, or any other store on the Pike or in the Ville.

Proper waste management embodies [REDACTED]'s community values. Plastic bags can only be recycled at specialized facilities. Join your fellow dorm mates and the rest of the [REDACTED] community for a plastic bag collection event on 2/26/16 to bring the plastic bags to be properly recycled.

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at [sustainability@\[REDACTED\].edu](mailto:sustainability@[REDACTED].edu).

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 4

Dear [Student]:

Get together to lower energy usage. For every \$1000 of energy consumed, about \$100 is consumed by unused electronic devices and chargers that are left plugged in. Unplug and join your friends in the common areas.



Energy Tip of the week:

Share resources to save energy. Utilize the libraries, dorm lounges and student centers around campus to share electricity.

****Join your peers and the rest of the Columbia community for an Earth Hour (turn off all lights and unplug all devices in your dorm room) this week: reduce your dorm room energy use!****

Waste Tip of the week:

Reduce the amount of trash on campus by choosing items that create less waste and last longer.

If you have any questions about [redacted]'s energy reduction strategies or waste management, please contact the Office of Sustainability at [sustainability@\[redacted\].edu](mailto:sustainability@[redacted].edu).

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

**Negative Affect
Email 1**

Dear [Student]:

When was the last time you thought about your impact on the environment?



Each year, you produce about 2.8 metric tons of carbon emissions, equivalent to about 3,000 lbs of burned coal. Efforts to mitigate climate change still have a long way to go and the need for change is urgent. You can play a part by considering your own contribution to electricity usage, as well as your commitment to recycling and composting.

Energy Tip of the week:

Remember to turn off the lights whenever you leave your room, the lounge or any other common areas. Every minute counts.

Waste Tip of the week:

Use reusable bottles and containers to reduce waste. Put your reusable container with your bag to remind you to take it in the morning

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 2

Dear [Student]:

What are you doing to mitigate climate change?

Small changes can lead to big consequences! When you choose to engage in less environmentally-friendly behavior, your actions add up and lead to climate change, including rising temperatures. Below are some ways to change habits for the better.



Energy Tip of the week:

Take the stairs as often as you are able. This will limit elevator usage, a major contributor to dorm electricity usage.

Waste Tip of the week:

In addition to printing double-sided, print two pages per side to save paper and weight in your bag. If you have pages with unused sides, save them and use them as scratch paper.

To help you dispose of tricky items, you will receive a brown bag that you can use to collect unwanted plastic bags. We will gather your plastic bag collections in about 10 days. Please write your Swat username on the brown bag and a Yes/No answer to the following question: Was this service useful?

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 3

Dear [Student]:

How do you feel knowing that others live in areas surrounded by your trash?

You produce on average 45 lbs. of trash each week. Most of it winds up in landfills in nearby communities or is incinerated and produces noxious gases along with toxic ash.

Chronic health conditions, such as asthma, have been attributed to individual poor waste management and it's your responsibility to act now. Here are some recycling tips to reduce your impact on the environment and your community.



Energy Tip of the week:

Wash laundry only when you have a full load in order to save both energy and water. To energize your savings, wash your laundry using the cold water cycle.

Waste Tip of the week:

Bring your own reusable when shopping at Target, Co-Op, or any other store on the Pike or in the Ville.

You only use your plastic bags for minutes on average, but these same plastic bags have a lifetime expectancy of hundreds of years. Own up to your responsibility and partake in a plastic bag collection event on 2/26/16 to bring the plastic bags to be properly recycled.

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 4

Dear [Student]:

This past year has been the hottest year ever recorded. You are part of the generation that relies most on energy. Energy reduction is your responsibility too! In your dorm room, for every \$1000 of energy consumed, about \$100 is consumed by unused electronic devices and chargers that are left plugged in.



Energy Tip of the week:

Share resources to save energy. Utilize the libraries, dorm lounges and student centers around campus to share electricity.

****Take responsibility and do your part by partaking in an Earth Hour (turn off all lights and unplug all devices in your dorm rooms) next week: reduce your dorm room energy use!****

Waste Tip of the week:

Reduce the amount of trash on campus by choosing items that create less waste and last longer.

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Semi-Control Emails

Email 1

Dear [Student]:

██████████'s Office of Sustainability is looking for ways to reduce energy usage and improve waste practices!

The President of ██████████ College signed the American College & University President's Climate Commitment in 2010 to move the institution toward carbon neutrality by 2035. An individual student produces about 2.8 metric tons of carbon emissions a year, equivalent to about 3,000 lbs of burned coal.



Here are some ways to increase sustainability on campus. You'll receive more tips over the next three weeks.

Energy Tip of the week:

Remember to turn off the lights whenever you leave your room, the lounge or any other common areas. Every minute counts.

Waste Tip of the week:

Use reusable bottles and containers to reduce waste. Put your reusable container with your bag to remind you to take it in the morning

If you have any questions about ██████████'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@██████████.edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 2

Dear [Student]:

Small changes can lead to big rewards.



Energy Tip of the week:

Take the stairs as often as you are able. This will limit elevator usage, a major contributor to dorm electricity usage.

Waste Tip of the week:

In addition to printing double-sided, print two pages per side to save paper and weight in your bag. If you have pages with unused sides, save them and use them as scratch paper.

***To help you dispose of tricky items, you will receive a brown bag that you can use to collect unwanted plastic bags. We will gather your plastic bag collections in about 10 days. Please write your [redacted] username on the brown bag and a Yes/No answer to the following question: Was this service useful? ***

If you have any questions about [redacted]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[redacted].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 3

Dear [Student]:

An average student produces around 30 pounds of waste a week, and approximately a third of that waste can be recycled. [REDACTED] trash is brought to an incinerator in nearby Chester.



Energy Tip of the week:

Wash laundry only when you have a full load in order to save both energy and water. To energize your savings, wash your laundry using the cold water cycle.

Waste Tip of the week:

Bring your own reusable when shopping at Target, Co-Op, or any other store on the Pike or in the Ville.

Plastic bags can only be recycled at specialized facilities. We will host a plastic bag collection on 2/26/16 to bring the plastic bags to be properly recycled

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Email 4

Dear [Student]:

Individuals make a difference, too! For every \$1000 of energy consumed, about \$100 is consumed by unused electronic devices and chargers that are left plugged in.



Energy Tip of the week:

Share resources to save energy. Utilize the libraries, dorm lounges and student centers around campus to share electricity.

****Please take part in an Earth Hour (turn off all lights and unplug all devices in your dorm rooms) next week: reduce your dorm room energy use!****

Waste Tip of the week:

Reduce the amount of trash on campus by choosing items that create less waste and last longer.

If you have any questions about [REDACTED]'s energy reduction strategies or waste management, please contact the Office of Sustainability at sustainability@[REDACTED].edu.

Thanks for encouraging sustainable living on campus!

From the Office of Sustainability

Appendix E – Pre-Intervention and Post-Intervention Behavioral Intent Survey

Please indicate your LEVEL OF INTENTION to engage in each of the following behaviors.

	Very Unlikely	Unlikely	Undecided	Likely	Very Likely
Decrease electricity consumption in residential halls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recycle.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decrease water consumption in residential halls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Donate money to environmental causes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consume/Support organic products.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Volunteer to help pro-environmental groups/events.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Read and educate myself on environmental issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix F - Pre-Intervention and Post-Intervention Behavioral Engagement Survey

At the moment, how EASY or DIFFICULT do you find it to engage in the following behaviors?

Select 'NOT APPLICABLE' if you have no access to engage in the corresponding behavior.

	Very Difficult	Difficult	Neutral	Easy	Very Easy	Not Applicable
Decrease electricity consumption in residential halls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recycle.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decrease water consumption in residential halls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Donate money to environmental causes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consume/Support organic products.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Volunteer to help pro-environmental groups/events.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Read and educate myself on environmental issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix F - Environmental Actions Scale

In the last six months, HOW OFTEN, if at all, have you engaged in the following environmental activities and actions? For each statement, please indicate whether you NEVER, RARELY, OCCASIONALLY, FREQUENTLY or VERY FREQUENTLY engage in a behavior.

	Never	Rarely	Occasionally	Frequently	Very Frequently
Educated myself about environmental issues (e.g. through media, television, Internet, blogs, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participated in an educational event (e.g. workshop) related to the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organized an educational event (e.g., workshop) related to environmental issues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talked with others about environmental issues (e.g., spouse, partner, parent(s), children, or friends).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Used online tools (e.g., YouTube, Facebook, Wikipedia, Twitter, Blogs) to raise awareness about environmental issues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Used traditional methods (e.g., letters to the editor, articles) to raise awareness about environmental issues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Personally wrote to or called a politician/government official about an environmental issue.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Became involved with an environmental group or political party (e.g., volunteer, summer job, etc.).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financially supported an environmental cause.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Took part in a protest/rally about an environmental issue.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organized an environmental protest/rally.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organized a boycott against a company engaging in environmentally harmful practices.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organized a petition (including online petitions) for an environmental cause.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consciously made time to be able to work on environmental issues (e.g., working part time to allow time for environmental pursuits, working in an environmental job, or choosing environmental activities over other leisure activities).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participated in a community event which focused on environmental awareness.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<p>Organized a community event which focused on environmental awareness.</p>	○	○	○	○	○
<p>Participated in nature conservation efforts (e.g., planting trees, restoration of waterways).</p>	○	○	○	○	○
<p>Spent time working with a group/organization that deals with the connection of the environment to other societal issues such as justice or poverty.</p>	○	○	○	○	○

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