A BEHAVIORAL ECONOMIC ANALYSIS OF CARBON-NEUTRAL ENERGY PURCHASING

By

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Abstract

Centuries of perturbance by human activity has threatened the ability of long-resolute environmental exchange systems to cycle particulate matter in a manner conducive to human success on Earth. We stand now in a time in our history with no direct parallel. Drastic and outside-the-box applications from all domains of science are needed. In the described experiments, I present a novel behavioral economic framework—one based on principles of operant demand—as a means of investigating the efficacy of environmental manipulations on "green" consumerism at community scale. In all experiments, participants are asked to make decisions regarding their likelihood of enrolling in a clean home-energy supply at varying prices. In Experiment 1, I unpack the preliminary performance of the task via examination of consistency within generated demand metrics, relation to existing measures of ecological concern, and predictive ability as it pertains to environmentally friendly action. Results suggest strong internal performance and divergence from existing measures, hinting at a novel aspect of sustainable behavior captured by the task. In Experiment 2, I evaluate the performance of the task as a framework for testing efficacy of scalable choice architectural intervention. Results suggest adequate task sensitivity to detect group distinctions in demand. Finally, in Experiment 3, I introduce a modified version of the task that employs a more ecologically relevant response (dichotomous yes/no responding). Overall findings indicate adequate task performance and viability for use as an evaluative instrument for prospective community intervention.

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A Behavioral Economic Analysis of Carbon-Neutral Energy Purchasing

We live now in a no-analogue state: a point of climatic disturbance incomparable to any point in documented human history (see IGBP, 2001). Our global ecosystem is in a state that has no direct parallel to any time during which *Homo sapien* has occupied a place on the planet (Zalasiewicz et al., 2010). Since the mid-19th century and debatably far earlier, the collective action of humans has become the driving force of change in the global environment. Such is the inference of the *Anthropocene*: a new geologic epoch to follow the *Holocene*, defined primarily by human-environment interaction as the driving force of planetary evolution (Crutzen, 2002; Crutzen & Stoermer, 2000; Steffen et al., 2007; see also Crutzen & Steffen, 2003; cf. Malm & Hornborg, 2014). The implications of this designation are monumental. As we progress through this no-analogue state, we do so with the understanding that life will change in dramatic ways, and in ways we have yet to fully understand (Thompson, 2010; see also Rockström et al., 2009a; 2009b).

The future is one rife with changes brought about via the shifting of planetary systems—ones upon which we have always depended for the cycling of vital particulate matter across ecosystems (e.g., carbon cycle, water cycle). Profuse disturbance of our natural environment through establishment of a human civilizational foothold has pushed these systems to new extremes. Widespread clearing of flora carbon sinks has greatly reduced the gaseous exchange necessary to properly regulate greenhouse gas (i.e., those that insulate and trap solar radiation within the atmosphere, much like a greenhouse traps solar radiation; e.g., carbon dioxide [CO_2], methane [CH_4]) presence in the inner atmosphere. Burning of fossil fuels at unprecedented levels, coupled with other uniquely human practices (e.g., domestication and large-scale breeding of cattle) have amplified the release of these gasses, posing direct risk to the long-term survival of life on Earth.

We rapidly approach what many scientists have labeled "the point of no return" (see IPCC, 2018). As the greenhouse effect continues to ramp up, the average global temperature will continue to climb, in turn producing widespread disturbances and further disruption of planetary system functioning. These changes we produce through daily activity pose threat of *accelerated* disturbances—those which produce feedback loops and thereby continue to foster change long after contributors have halted. For example, dense deposits of methane, often found crystalized into clathrates, are found in areas of relatively high pressure (e.g., Arctic seas). As regional temperatures rise, *permafrost*—areas of typically stable temperature which remain frozen year-round—will begin to thaw for the first time in centuries, perhaps millennia. Much of the methane clathrates or bubbles of methane gas stored in this frost will inevitably vacate to the lower-density inner atmosphere, where they will have a concerted effort in accelerating the greenhouse effect in that region.[1] Added methane will further increase temperature, in turn further increasing methane release.

From a global perspective, the ecological impressions we collectively make today will have impacts far reaching into the future, perhaps decades from now. Recent reports from the Intergovernmental Panel on Climate Change (IPCC) have underscored the importance of keeping average global temperature change within a range of 1.5°C, as exceeding this may produce *runaway* change (IPCC, 2018; see also IPCC 1992; 1995; 2001; 2007; 2014). Considering the probable environmental justice issues which we already expect to arise—clean water shortage

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[1] Scientists have observed a potent insulating effect of methane gas, in turn serving as an excellent contributor to the greenhouse effect. Fortunately, methane is shown to have a relatively shorter "life" as it pertains to existence in the atmospheric composition.

and soil erosion leading to food scarcity, increased prevalence and intensity of severe weather, greater likelihood of epidemics, widespread flora and fauna extinction, and climate refugeeism caused by rising sea levels or some combination of these preceding outcomes—controlling the rate of change is perhaps the greatest concern we have ever faced as a species.

From an existential standpoint, the humans of today's generations may well be the most significant to walk on Earth. Living in an epoch defined by human negligence places a great burden upon those capable—at some capacity—of altering this trajectory. Every action matters. But the collective outcome of such a change is one that we as individuals may never directly experience. To curb behavior and sacrifice familiar comforts for the solitary benefit of humans not yet conceived of is a monumental effort, and one that will take cooperation and buy-in on a massive scale. Solutions necessarily involve contributions from all ranges of scientific and technological innovation, as neither will alone be sufficient to generate change at such a crucially large magnitude. Advancements have been and will continue to be interdependent—new developments in science will inform technology, and technological breakthroughs will permit new scientific endeavors. Success will also depend in large part upon behavioral interventions: a new approach to green living will only be viable so long as people are willing and able to interface with cutting edge infrastructure. Navigating the interdisciplinary playing field has never been more essential than it will be in the coming years.

Notably, IPCC reports have called for two distinct lines of work to prepare for the existential threat. *Mitigation*, or the curbing of further climatic change, should be a foremost priority while we yet remain on the safe side of the cautioned 1.5°C change. Such solutions should focus on (but not be limited to) reducing buildup of greenhouse gasses (e.g., curbing carbon dependence; eating a plant-based diet), aiding the return of planetary cycles to full functionality (e.g., colossal tree preservation and planting initiatives; supporting growth of algae and phytoplankton), and in some cases, reversing regional change acceleration (e.g., enhancing the natural solar reflectivity of glacial ice). Inevitably, however, climatic change will continue to yield unavoidable disturbances to daily life for at least some segment of the population, and so the IPCC also calls for *adaptation* solutions. These approaches will focus on means by which we—life on Earth—can deal with what is and carry forward in a productive manner. Solutions should emphasize those of environmental justice, broadly. Provision of necessities for survival including access to nutritious food and clean drinking water, shelter and protection in the event of relocation due to sea water flooding or extreme weather, and safe haven from pandemic, heat, or human-human conflict – all are likely to be points of emphasis for the global sustainability movement.

Foundation of Global Sustainability Initiatives in the Social Sciences

Concern over human degradation of the natural ecosystem has centuries of documented history (see Labaree, 1959; Young, 1978). For years, astute observers expressed unease as civilizations grew and action was taken to secure footings in agriculture, metropolis, and globalization. More recently, it was observations taken at the 1950’s Mauna Loa Observatory in Hawaii that first drew attention to the extensive emission of carbon dioxide as being potentially problematic (Keeling, 1978; Mook et al., 1983). These observations, which are chiefly focused on analysis of atmospheric composition, highlighted potential trends between this elevated presence of greenhouse gasses and fluxes in mean global temperature. It would be many more years before *climate change* became a term suggestive of the existential threat recognized today.

Initial academic efforts to address sustainability focused primarily on pollution moderation and human-environment interaction, as in Aldo Leopold’s *A Sand County Almanac* and Rachel Carson's *Silent Spring*. Mid-century legislative efforts such as the 1955 Air Pollution Control Act and its 1963 expansion into the Clean Air Act under the Johnson Administration set the tone for further governmental action (see Air Pollution Control Act of 1955, 1955; Clean Air Act of 1963, 1963). By 1970, several presidential task force efforts had been enacted to assemble a convincing body of evidence of environmental perturbation and, at some length, inform action with potential to reduce harm to ecosystems and their organismic inhabitants (see EPP, 1965; Task Force on Environmental Health and Related Problems, 1967). Notably, each of these group assemblies had, as a primary task force member, a scientist trained in social scientific practice. Many of their suggestions and inferences were yet misguided—cities were villainized as a leading contributor to environmental disturbance, whereas we now know the sprawling suburb as a comparable culprit—but the intention of these groups' assemblies was impactful in drawing the attention of the upper echelon.

Behavior Analysis: An Advancing Framework for Change

In the years since these early task force efforts, involvement of the social sciences in the sustainability agenda has remained resolute, if a bit under-representative. Of the efforts primarily demonstrated to-date, the vast majority of these have examined behavioral correlates to "green" living—attitudes and beliefs, largely (see O'Connor et al., 1999; see also Shove, 2010). These are undoubtedly critical to understand in their own right. As we progress deeper into mitigation endeavors, having a strong conceptualization of those most *and* least likely to comply with enacted change will be crucial. Yet these efforts are not alone enough. We need now turn to rigorous and replicable demonstrations of the efficacy of various proposed measures to produce drastic and immediate changes in behavior. Efforts need be scalable: investigations should be capable of generating data sufficient to inform urban planning and public policy efforts. Such is the nature of behavior analytic intervention.

Shortly after the release of the foremost report by the Task Force on Environmental Health and Related Problems, Baer and colleagues published their seminal article (1968) in the *Journal of Applied Behavior Analysis* (JABA), thereby establishing the preliminary guidelines for what would become a critical subfield of a broader behavioral (i.e., Skinnerian) science. Within years, initial behavior analytic publications focused on sustainable living were published under this purview. The release of these works tended to follow the trend of general interest expressed by the public in areas of sustainable living. Burgess and colleagues (1971) and Clark and colleagues (1972), the earliest publications from ABA in the sustainability movement, focused on low-cost procedures to promote litter collection by a youth sample. This coincided in large part with the ongoing public concern over pollution and depreciation of our natural landscapes (e.g., Cuyahoga River fires, most notably in 1969; *Keep America Beautiful*'s 1971 ad campaign featuring Iron Eyes Cody). The modest but promising results of these initial studies gave way to an entire line of work focused on better understanding procedures for promoting more sustainable living.

By the start of the first World Climate Conference in 1979, 16 *empirical* articles had been published in JABA with some focus on sustainability or climate change. Of these, six examined specifically litter control as a concentration of interest. Chapman and Risley (1974) offered small payouts to children in an urban setting in exchange for full bags of litter. Hayes and colleagues (1975) introduced a technique for paying participants on a probabilistic system. Referred to as the *marked item technique*, the procedure involved discretely marking planted litter, redeemable for larger magnitude rewards should they be unknowingly collected by participants as part of their overall litter collection effort. (This approach would end up as a key component of replication efforts in years to come; see Bacon-Prue et al., 1980.) Another six articles focused on energy use reduction techniques to lessen the impact of household activity on the mean global carbon output. Kohlenberg and colleagues (1976) used a system of feedback and incentives to reduce household electricity use during *peak* times. Notably, researchers implemented a prototypical, real-time feedback delivery system: a lightbulb stationed in the kitchen area of the household would shine if household energy use exceeded a predetermined threshold.

During this decade, behavior analysis also released the first of its work examining the plagued transportation system and the excessive human dependence upon personal vehicles as a primary form of locomotion. Foxx and Hake (1977) and Hake and Foxx (1978) used low-cost rewards to incentivize a decrease in average miles driven by a sample of undergraduate students. Participants were required to submit for regular odometer checks but were left blind to the motivations of the researchers. Both studies concluded in favor of the use of these inexpensive—often free, as in the offering of a tour through a local mental health facility—rewards to greatly reduce a behavior that remains a major climate change contributor today.

The 1980's marked a turning point for conversations in the domain of human-environment ecology. By 1985, scientists had reached international agreement that elevated atmospheric temperature was indeed a facet of accumulating greenhouse gasses. Climate scientist James Hansen delivered his infamous plea to the U.S. Senate Committee on Energy and Natural Resources for climate action in 1988, highlighted as one of the first times *climate change* as a concept entered the public spotlight (see Sinclair, 2018). Shortly thereafter, collaboration between environmental scientists on a global scale led to the preliminary foundation of the IPCC. In the area of behavior analysis, publication focused in "green" living was once again fruitful. By

1989, an additional 13 studies producing novel, experimentally derived findings were added to the literature. Many of these were simple expansions of previously conducted work. O'Neill and colleagues (1980) used a modified trashcan to establish greater stimulus control for the collection and deposit of litter at a sporting event. Foxx and Schaeffer (1981) and Hake and Zane (1981) continued to advance understanding of transportation modulation. The former examined incentivization at a small research consulting firm, while the latter expanded upon previous work in a specifically undergraduate population. Five studies sought supplementary data to more effectively reduce electricity and fuel oil consumption by the typical household. All things considered, the field advanced at an exciting pace.

Many of the contributions published during the decade were relatively novel approaches to behavior change. Jacobs and colleagues (1982) diverged from the preexisting transportation literature fixed on personal miles driven by shifting their lens to factors influencing *carpooling*. Winett and colleagues (1982; 1985) used a novel modeling-type approach to better inform participants as to the importance of, and means of achieving, home energy-use reduction. Two of the studies published in this span stand out as exceedingly unique. Van Houten and colleagues (1981) aimed to reduce energy use of an administrative building solely via modulation of elevator ridership. Researchers posted prompts and feedback as a preliminary measure. After assessing the efficacy of this signage unaided, they increased the delay to elevator doors' opening such that prospective riders were forced to wait up to 32 s to enter and access the elevator car. Increasing delays had a substantial impact on elevator rides and a subsequent contribution to overall building energy savings. Alternatively, Agras and colleagues (1980) conducted the first and only broad-scale, quasi-experimental examination of policy change and its impact on eco-friendly behavior. Hosted in the California Bay-area, the researchers monitored water use by three communities during the drought spanning 1976-1977. Local leadership enacted policies placing monetary fines on excessive water use as an attempt to curb wasteful water consumption. Analysis suggested a significant ability of such measures to reduce problematic behavior.

By the turn of the '90s, much of the public spotlight, and that of behavior analytic researchers, had moved beyond sustainability and climate change. During the decade, only four pro-environmental studies were published with empirical methods in behavior analytic journals, all of which focused on a relatively novel target behavior—recycling and waste management. Of these, two examined free-cost manipulations of response effort—reducing the distance to properly dispose of recyclable waste (i.e., Brothers et al., 1994; Ludwig et al., 1998). The others maintained the precedented focus on low-cost intervention to achieve desirable behavior change. Austin and colleagues (1993) used prompting in an administrative building to yield greater compliance in proper waste management by employees. Uniquely, Keller (1991) examined recycling procedures scaled for application in a community setting. The researcher selected two comparable neighborhoods and incentivized greater recycling via promised delivery of donated grocery gift cards to a local community shelter. In all cases, researchers noted modest but efficacious outcomes.

In continuing the trend, the early 2000's demonstrated a paralleled apparent disinterest in sustainable intervention. Only three additional studies were published. Yet, these studies promised another round of unique and rousing approaches to achieving positive human-environment interaction. Staats and colleagues (2000) focused on logical behavioral antecedents to energy efficiency in an office building—keeping office thermostats consistent and keeping heating grates clear of obstruction. Simple feedback and prompting delivery established widespread compliance and an overall reduction in building carbon footprint. Schroeder and colleagues (2004) reported the only publication to-date to focus on political action as a primary dependent variable. Authors targeted business owners in a coastal community for whom shoreline viability and tourism was critical. Regular delivery of an experimental newsletter containing information regarding the shoreline health, relevant legislative action, contacts for local leaders, and modeled contact (e.g., letters, phone calls) produced greater political outreach and activism by recipients. Finally, Manuel and colleagues (2007) generated the first findings of their kind, reporting on means by which to increase use of reusable dinnerware over single-use disposables. A combination of informational posters, prompting by staff, and reduced response effort (e.g., making more reusables available) greatly decreased ecological footprint in a cafeteria setting.

More recent work has been published with renewed vigor. From 2010 to present, 16 uniquely experimental papers have been featured across five leading publication outlets. These works have covered a full gamut of behavioral categories, including energy use (n = 8), waste and recycling (n = 4), transportation (n = 2), reusables, and resource dependence. Many of these serve as greater extensions of early work, including Bekker and colleagues' (2010) use of feedback, prompting, and rewards to yield energy reduction in a college dormitory. Similarly, Miller and colleagues (2016) employed a combination of prompting and response effort manipulation to generate greater recycling efforts in a university academic building.

Many of these works also serve as entirely unique presentations of behavioral science effort. Reed and colleagues (2013) used behavioral economic methods in a quasi-experimental evaluation of North American fuel-oil use. Modeling via a field-standard equation and derivation of relevant metrics (e.g., α, or alpha) revealed a pattern of consumption highly resistant to increasing price, thereby reminiscent of addiction-like engagement. Camargo and Haydu (2016) exemplified a “tragedy of the commons” scenario via simulation of a resource collection game. Staggered across time, participants engaged with a virtual fishery wherein collected fish could be exchanged for real money following session completion. All resources were drawn from a single, exhaustible pool of fish shared among all participants regardless of where in the participant order one fell. Additionally, only the first round of participants received guidance from researchers for how to engage with the fishery—those subsequently entering the simulation were instructed to confer with those ending their session for information as to how to engage the task. Researchers found that those who received prompts regarding the dwindling state of the resource pool were more likely to behave—and instruct others to behave—in a more sustainable manner.

In the area of low-cost procedures, several studies examined basic environmental modifications to achieve easily maintained approaches to sustainable living. Fritz and colleagues (2017) removed readily accessible trash receptacles and monitored likelihood to properly dispose of waste in a recycling bin. Venditti and Wine (2017) provided a free-to-use air pump at a local human services organization and informed participants of the importance of proper tire pressure for maximizing vehicle fuel efficiency. Simply granting low-effort access to the pump increased the average likelihood participants drove with fuel-efficient tire pressure. Most recently, Szczucinski and colleagues (2019) introduced brightly painted receptacles and informational materials to promote more appropriate composting behavior in a cafeteria setting. Increasing the response effort to use the bin was thought to increase attending to instructional placards with photos of items that could or could not be disposed of in the bins. Combined with the increased stimulus control, researchers were able to increase overall compost weight while maintaining low rate of contamination by inorganic waste.

Filling the Void in Behavioral Science Sustainability Research

Overall, fifty-two articles with empirical methodologies and data-driven conclusions have been published in behavior analytic journals since the inception of JABA. These articles span a respectable array of targeted behaviors and include a full range of behavior analytic principles as means of contacting desired change. Turning now toward a full overview of these works beyond their historical context, several gaps in the literature remain unmet. Given the unique utility and applicability of behavior analysis to contribute to the sustainability agenda, it is critical these lapses in methodological understanding and focus be filled by future research.

Perspectives on Choice Architecture

Within the greater purview of behavioral sciences has emerged a line of research investigating the effects of relatively minute environmental modifications in producing more desirable patterns of behavior within a community setting. Popularized in large part by Thaler and Sunstein's 2008 novel *Nudge*, the premise of these experimental "tweaks" to one's operating environment is to make more likely the decision seen as being of greatest benefit to the consumer or greater well-being of the subgroup to which the consumer belongs (e.g., the familial unit). Nudges have traditionally been demonstrated from within a financial context, as with the exemplar examination of the default setting in employer-offered retirement savings programs: with the understanding that many prospective employees do not make later adjustments to the savings arrangement proposed at the time of hiring, how then can we arrange these default options to most optimally benefit choosers in the long-term? This widely applicable conceptualization of choice architecture is thought to embody what Thaler and Sunstein describe as *libertarian paternalism*, or the practice of encouraging choices with potential to improve quality of life while still permitting decision makers to freely make choices without undue influence from coercive or forceful practices. To promote a certain behavioral ideal without the need for mandates or the infringement upon everyday freedom is opportune for policy construction and arrangement.

Attempting to change behavior via application of choice architecture presents a handful of benefits to the change agent. First, the tactic presents an incredibly wide range of foci for intervention, as any number of elements in the choice arrangement can be modified to address flaws in individual decision making (see Johnson et al., 2012). For instance, at a broad level, those designing the environment have to allocate attention to the categorical choice elements of task arrangement (i.e., how is the choice structured) and/or choice construction (i.e., how the choices are described). Johnson and colleagues (2012) conducted a review of existing choice architecture literature to compile a working list of tools available when constructing a nudge-type environment. Authors found eleven viable mechanisms for influencing the task arrangement and combatting common issues potentially influencing poor choice by the consumer (e.g., choice overload). Such highlighted methods include use of default options, supplying fewer alternative choices so as to reduce overload, and limiting decision making timeframes to prevent procrastination. The flexibility and dynamic nature of choice architecture provides numerous avenues by which behavior can be positively influenced, a desirable feature for limiting the need for forceful intervention as might be commonly seen in more typical policy implementation.

An additional point to consider in the use of choice architecture is the degree to which the general populous approves of their application. The recent surge of research in the domain of choice science has led to discussion on the ethical considerations when employing the nudge (e.g., Hansen & Jespersen, 2013; Selinger & Whyte, 2011; Sunstein, 2015). To what extent is the libertarian essence retained as these choice arrangements are adapted for new contexts? Hausman and Welch (2010) argue that, although in some cases permissible, the "free choice" as embodied by the nudge is blurred in many novel choice architecture arrangements, particularly in circumstances when the decision can be viewed as minimally paternalistic (i.e., persuasive toward some end, but not necessarily one of sole benefit to the chooser). Sunstein (2016) examined the preferences of a nationally representative sample of Americans—those for whom nudges are frequently designed. On average, individuals supported the prospective use of influential choice architecture so long as the promoted ideals were not seen as nefarious and were generally in-line with values of the decision maker. It is therefore essential that the end goal of any such arrangement is kept transparent and readily identifiable to the larger body of those making choices so as to ensure persuasive influence is not inadvertently incorporated.

Perhaps most importantly, there is growing evidence to suggest choice architecture is broadly efficacious in application. In their review of over 400 choice architecture arrangements, Szaszi and colleagues (2017) found that many ongoing efforts are revealing positive results in a range of settings, including field applications and naturalized environments. Less than half of the studies flagged in their review were conducted in a laboratory setting, a nod to the relatively high degree of applicability and resulting rigor of evaluation. Yet some objection to their use is worth noting. For instance, John and colleagues (2009) present a comparable alternative approach for influencing behavior, particularly for within a political context. Labeled "think" interventions (as opposed to nudge), authors note relative advantages over nudge application in that the latter fails to address the root of problematic decision making. Whereas some choice architecture can be viewed as a "bandage" of sorts, an approach to behavior change that forces consumers to consider the implications of their choice is far more desirable. However, the ease of application presented by nudges yields a procedure with *immediate* vast potential for behavior change. For these reasons and others, the use of choice architecture has seen a rise in popularity among lawmakers in recent years (e.g., President Barack Obama publicly pushing for use of behavioral science tactics, including the use of choice arrangement, by federal agencies). Emerging research has now demonstrated beneficial result of choice architecture as applied to decisions pertaining to issues of societal importance not limited to health outcomes (e.g., Hollands et al., 2013; Skov et al., 2013; Thorndike et al., 2012) and, more recently, global sustainability outcomes (e.g., Costa & Kahn, 2013; Ismael & Shealy, 2018; Shealy et al., 2019)

The novel application of choice architecture to environmental policy development shows early promise. To incorporate nudges into the overarching framework for addressing global sustainability deficits may well present a number of advantages, many of which are highlighted in the preceding discussion. To date, "green" nudges have acquired momentum and an increasing body of evidence supports their use for encouraging pro-environmental behavior in a variety of contexts (see Schubert, 2017). A commonly used choice arrangement to promote behavior relevant to the sustainability movement is that of the default enrollment, thus forcing an opt-in/opt-out comparison (see Sunstein & Reisch, 2013). In a classic example of opt-in/out research conducted by Shepherd et al. (2014), researchers examined the rate of organ donation enrollment when participants are either automatically enrolled and permitted the chance to opt-out at a later date, or when participants are simply permitted to opt-in at any time. Analysis of organ donor program statistics from 48 participating countries infers a significant benefit to overall organ donations when countries host an "opt-out" approach, wherein citizens are by default enrolled in the organ donation program.

In the context of "green" living, opt-in/opt-out arrangements have been primarily used in the domain of home energy use, either with respect to electricity source (i.e., generation) or general use patterns. For instance, Fenrick et al. (2014) examined the role of opt-in and opt-out choice as it pertained to enrollment in a critical peak pricing program aimed at modulating electricity use during times of highest demand (i.e., summer heat). Those *not* automatically enrolled in a bill protection plan were more apt to reduce electricity use due to subsequent monetary savings, as opposed to those given the option of opting out of the savings program.

Pichert and Katsikopoulos (2008) examined the role of choice arrangement – opt-in versus opt-out – in influencing enrollment in clean home energy supplies. In their study, participants were prompted to imagine having recently move into a new residence and are asked to make choices with respect to their home electricity utility. Folks that were automatically enrolled in renewable electricity sources were more likely to remain enrolled, even at higher prices. Further, those participants defaulted into green energy were unwilling to unenroll without substantial compensation, an indication of exceeding demand for a commodity already secured (as opposed to those prospectively available, referred to as the endowment effect). Ebeling and Lotz (2014) similarly examined the default enrollment effect in producing greater buy-in to cleaner energy sources. In an examination of over 40,000 households, some of which were presented the option of opting in to renewably sourced energy and others simply defaulted in, those in the latter condition were significantly more likely to purchase green electricity even at higher prices.

Behavioral Systems Change

A primary misrepresentation—intentional or not—of the current climate crisis is the role of the everyday consumer. Although the decisions made by each individual are collectively impactful, the true responsibility of the state of affairs may well be better placed upon those with greater decision-making power—policy makers, conglomerates, and other members of the upper echelon. This inconvenient reality poses some emerging challenges for social scientists seeking to make an impact in the sustainability movement. Namely, how we go about changing the behavior of those seemingly immune to everyday efforts has become a chief concern. An increasingly robust body of literature (see Seniuk et al., 2019; see also Glenn, 1988; Glenn & Malott, 2004; Glenn et al., 2016; Ulman, 2006; Zilio, 2019) within the behavioral systems approach documents the applicability of behavioral science to place pressure on those at the upper-end of the decision making ladder, forcing a change in the system to yield cascading difference for those at lower rungs—those likely to yield more desirable decision making without the need for overt effort expenditure (e.g., the ubiquitous shift toward sustainable electric vehicle roll-out by vehicle manufacturers, and the resulting jump in electric vehicle purchases by the typical consumer). Interventions here grounded should be among leading efforts.

Behavioral Economics

A relatively more modern dimension of behavioral science, behavioral economics presents a unique framework from which to examine decision making as it pertains to reinforcer valuation. Such is an important aspect of sustainable living: the excessive value placed on various facets of daily life—attachment to personal combustion-fueled vehicles, red-meat-dominated meals, and petroleum-based plastics, as a starting place—presents extensive difficulty when conceptualizing new approaches to curb wasteful practice. Behavioral economic methods are grounded in a rich history of experimental analysis of behavior, thereby providing a strong foundation from which to study choice in a variety of settings. Via incorporation of concepts from microeconomics, ecology, and behavioral science, behavioral economic examination provides a unique lens from which to interpret behavior.

Operant Demand

A form of behavioral economic framework focuses on choice as influenced by changing effort requirement. Emerging as an alternative to ongoing progressive ratio-type assessment, operant demand engages respondents to make choices to *consume* or "purchase" a given commodity in light of escalating cost. In foundational work, non-human subjects were presented palatable rewards accessible at increasing work requirements such that researchers could derive a work function and a negatively decelerating rate of consumption with respect to increasing price. Nonlinear regression could then be used to describe the observed reinforcer contact to produce additional metrics unique to the commodity in question (e.g., unit elasticity).

Operant demand methods present a relatively flexible means of examining choice as influenced by changing cost. A long history of work exists describing choice in both a human and non-human model. In either instance, prototypical work requires subjects to emit responses—often those with ecological relevance, as in a plunger pull for human work or nose pokes for rat models—to obtain their desired reinforcer. Early work in human-operant settings examined willingness to defend baseline consumption (e.g., maintain rate of consumption observed without imposed cost) in a variety of drug-administration arrangements. Bickel and colleagues (1990; 1991) offered participants an opportunity to earn cigarette puffs in exchange for pulling levers in a laboratory setting. Shortly thereafter, studies emerged seeking to replicate this early work and expand the utility of operant demand methods for understanding human choice (e.g., Bickel et al., 1993; DeGrandpre et al., 1992).

Hypothetical purchase task. The use of operant demand methods to study human choice—while efficacious—present a number of conceptual difficulties. Foremost, these methods can be cumbersome and time intensive, placing a great resource strain upon both the respondents and the research team. Application of operant demand frameworks present additional ethical barriers. Those completing demand tasks are customarily asked to have some direct contact with the reinforcer (i.e., the outcome of the work task). Such is a troublesome notion when considering choice in the presence of illicit and potentially harmful drugs of abuse. To bypass these negative drawbacks, researchers in the late 1990's drafted derivations of rapid operant demand tasks through which subjects could report work expenditure without direct interface with commodities in question. These hypothetical purchase tasks (HPTs) thusly provided researchers with a means of continuing to study reinforcer valuation in increasingly novel samples without risk of ethical quandary while maintaining the experimental robustness characteristic of behavioral economic and behavior analytic practice.

The earliest of these tasks—Petry and Bickel (1998)—provided a rough approximation of modern versions in that participants were asked to make purchasing choices using "play money." Participants were provided a brief vignette to constrain responding in a manner comparable to a realistic scenario and asked to indicate decisions to obtain and ingest illicit drugs (e.g., heroin, Valium) under changing stipulations. An extension of this and the first to closely resemble modern purchase tasks, Jacobs and Bickel (1999) used an entirely hypothetical format (e.g., no play money) to identify purchasing habits of cigarette and opioid users as they pertain to preferred substances of abuse. Respondents indicated *per unit* purchases at unit prices ranging from $0.01 (free) to $1120, with and without the competing commodity made concurrently available. The use of a vignette similarly constrained responding to match that of real-world choices; such an inclusion would become a standard for future HPT use.

In the years to follow, several replications of early purchase task success bolstered evidence to suggest viability for examination of economic decision making in typically difficult-to-assess scenarios. These most classically appeared as commodity-specific measures. As a direct extension of early HPT work, Field and colleagues (2006) presented the first of a sequence of Cigarette Purchase Task (CPT) measures (see also Reed et al., 2020). A number of derivations have since appeared, notably from MacKillop and colleagues (2008), Murphy and colleagues (2011), and Few and colleagues (2012). Similarly, Murphy and MacKillop (2006) presented a purchase task method (APT) specifically aimed at measuring alcohol-related choice (see also Kaplan et al., 2018). This work advanced through—primarily—the efforts of Murphy and colleagues (2009), Yurasek and colleagues (2013), and Morris and colleagues (2017; see also Amlung et al., 2012). Most recently, additional tasks have emerged with specialization in a range of other substances or commodities, not limited to cannabis (e.g., Aston et al., 2015a; Collins et al., 2014), cocaine (e.g., Bruner & Johnson, 2014; Strickland et al., 2016), tanning (e.g., Reed et al., 2016), gambling (e.g, Weinstock et al., 2016), and pornography (e.g., Mulhauser et al., 2018).

Of significant note in the purchase task literature is the emphasis placed on measure consistency and validity, as well as scalability for the potential informing of public policy development. Roma and colleagues (2016) provide a relatively constrained set of parameters dictating the ideal construction of a prototypical purchase task. Specifically, authors note the viability of either *quantity purchased* or *likelihood of purchase* as meaningful response paradigms for the evaluation of choice behavior. Guidelines indicate the essential nature of a standardized vignette for the establishment of constraints on responding typical of those experienced in a natural choice setting (e.g., budgetary constraints, a timeline for expected consumption, inability to stockpile individual units) as well as the inclusion of a photo of the product being purchased and an emphasis on a greater number of prices to produce robust responding.

A number of efforts have been made to either (a) demonstrate the congruence between decisions made in the hypothetical scenario depicted via the characteristic, or (b) examine the specific operations which primarily influence purchase task responding. A leading example comes from the effort of Amlung and colleagues (2012) to demonstrate the validity of the APT to reflect real-world purchasing of alcohol consumers. Researchers provided participants with real money with which to make alcohol purchasing decisions. They then correlated these with responses on an APT completed *a priori*. Results suggest an adequate degree of overlap, thus supporting the validity of these measures. Similarly, Strickland and colleagues (2017) presented multiple purchase tasks measuring demand for conceptually comparable products (e.g., soda and alcohol) to demonstrate the selectivity of these measures, in that results reflected sensitivity via differences in demand for similar commodities (i.e., correlation between clinical measures of alcohol and alcohol demand, but not clinical measures of soda consumption and alcohol demand). These demonstrations have been critical in building a base to establish the use of purchase task methods outside a niche area of behavioral economics.

In light of these collective efforts to provide evidence for the use of purchase task methods in a variety of settings, Roma and colleagues (2018) suggest the viability of HPT garnered results for informing policy development. To contact policy enaction with evaluated behavioral approaches and enact change at scale is, as previously discussed, a necessary step for advancing the sustainability agenda. Given the utility of the hypothetical purchase task for measuring behavior in historically problematic settings, purchase task evaluation provides an interesting and potentially meaningful angle from which to examine this sustainable decision making.

There exists already a precedent in the behavior analytic sustainability literature for this type of examination. Described above, Reed and colleagues (2013) applied a field standard equation to publicly accessible sales records of oil in the United States and Canada. Derived indices indicate a problematic rate of purchasing in that decision making appears uninfluenced by imposed cost—purchasing continues at nearly stable rates even at relatively high per barrel prices. The implication of this outcome is a potentially troubling one: simply increasing the cost of oil is not sufficient to drive down purchasing demand and subsequent use. In a more recent effort, Kaplan and colleagues (2018) surveyed participants as to their willingness to purchase reusable shopping bags at a series of escalating prices. Interestingly, those that demonstrated greater environmental concern per an externally validated scale took *less* bags at free cost as opposed to other respondents but were also willing to purchase *more* bags at relatively greater costs. These studies together begin to present a new understanding of how price may impact decision making and "green" consumerism in environmentally relevant circumstances. More work is needed in this domain.

The purpose of the current set of studies is to vet and apply a novel purchase task—one examining willingness to purchase clean energy—as a mechanism to evaluate behavior change as it pertains to sustainability. I chose home electricity as a commodity of choice given its ubiquitous importance and tangible unit of measure (i.e., kilowatt hours), as well as renowned relevance in ongoing renewable efforts. Study 1 will introduce the novel choice framework, evaluate its performance in light of extant literature on HPT development, and compare generated metrics to existing, previously validated measures of ecological concern to evaluate the scope of behavior captured. Study 2 will then test the value of the task as a potential mechanism for evaluating "nudge" type interventions intended to influence behavior using highly scalable choice architecture. Specifically, I will divide participants in line with an opt-in/out assessment. Finally, Study 3 presents an alternative task derivation with a proposed response of greater ecological relevance and a more versatile framework for application.

General Methods

Participants

I recruited all participants via Amazon Mechanical Turk (mTurk), an industry-leading crowdsourcing platform that provides researchers with direct access to a large research demographic roughly representative of the United States average (with options for more specific targeting based on state residence, health, employment, etc.). As of writing, several studies have examined the effectiveness of mTurk as a vehicle for research recruitment; data confirm the viability of the tool for use in distance-study of behavioral habits (see Berinsky et al., 2012; Goodman & Paolacci, 2017; Paolacci et al., 2010), and particularly for use in behavioral economic hypothetical choice task assessment (see Morris et al., 2017; Strickland et al., 2019; Strickland & Stoops, 2019) Individuals are recruited on the basis of small monetary payouts provided in exchange for the completion of tasks requiring uniquely human input (e.g., research surveys); in this case, workers were compensated with a payment of $0.60, or an average payrate of approximately $0.05/working minute.

Materials and Procedure

Participants completed study materials independently using either a personal computer or mobile cellular device. Following completion of informed consent (Appendix A) and a brief demographic questionnaire, respondents progressed through survey materials as described in each respective section. Data here represented were collected prior to the Coronavirus 2019 outbreak. All procedures were approved under Human Subjects Committee – Lawrence protocol #20635.

Survey Design

I designed all materials using Qualtrics' Experience Management survey platform (https://qualtrics.com/). The general aesthetic of the surveys was made consistent in a manner that replicates a utility company's cyber environment (i.e., website) where participants likely had history paying bills and requesting services (i.e., natural antecedents). The survey language was thought to establish a hypothetical scenario in which the reader's regular utility company had changed its energy supplier, and thus the respondent is now capable of selecting preferences for a newly offered electricity commodity.

eHPT. The novel electricity purchase task represents an adaptation to the typical purchase task approach (i.e., "How many would you purchase at X price?"; Roma et al., 2016), deemed necessary to adequately capture home electricity purchasing.[2] Participants first read through the following brief vignette, the purpose of which was to constrain responding in a manner comparable to what might be expected under typical environmental constraints:

> As part of the transfer to your new electric utility company, you now have the option of receiving 100% renewable energy via wind-farms in your area. Before we can provide efficient and equitable access to this clean and renewable form of electricity, we'll need to update our pricing system based on the needs and preferences of our customers. You have not been automatically enrolled in this program as of now, so standard opportunities for electricity are still available.

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[2] I thought it unreasonable for the average respondent to accurately respond to the question, "How many kilowatt hours of electricity would you purchase/use if they were $.XX each?"

Remember that more conservative energy use can result in sizable reductions to energy costs.

After indicating understanding of the scenario through completion of several comprehension checks, participants indicated the likelihood they would make purchasing decisions regarding renewable energies at each of a series of escalating *per kilowatt hour* (kWh) prices. The survey generated monetary values and presented these as a raw monthly expense by automatically multiplying the 2017 average *per person* monthly energy use in kWh (333.29; U.S. Energy Information Administration, 2019) by the number of household residents indicated in the preceding demographic questionnaire and piping the product into the survey text. The result was a 15-price array ranging from $0.00 (free) to $0.50 USD per kWh (calculating total cost as the product of price per kWh, average per person kWh usage, and number of reported household residents), with each price serving as a discrete assessment of willingness to purchase electricity based on monthly expenditure representative of the unique expectations for each household (i.e., simulating progressive ratio relative reinforcer efficacy). All prices were displayed on the same survey page.

New Ecological Paradigm Scale. In addition to the novel eHPT, participants completed the 15-item New Ecological Paradigm Scale (NEPS), a 5-point Likert-type scale assessment of environmental concern (Dunlap et al., 2000). The scale presents a series of pro- (e.g., "The balance of nature is very delicate and easily upset.") and anti-ecological statements (e.g., "Humans have the right to modify the natural environment to suit their needs.") to which participants indicate their level of agreement (ranging from "Strongly Agree" to "Strongly Disagree"). Scores range from 15-75, where higher sum values are said to reflect greater ecological concern (Dunlap et al., 2000). The most recent version of this scale demonstrates a strong correlation with previously validated versions (*r* = .61; Dunlap et al., 2000; Dunlap & Van Liere, 1978) and thus demonstrates adequate predictive ability (Noe & Snow, 1999).

Monetary discounting. As an additional measure of tolerance for delayed rewards—an essential aspect of decision making as it pertains to per month commodity cost—participants completed a five-trial adjusting delay monetary discounting task (Koffarnus & Bickel, 2014), in this case adapted for seamless incorporation into the preestablished survey aesthetic. Participants indicate their preference between an immediately available sum of money and one presented at some delay to provide a rapid assessment of participant discounting as it pertains to monetary reinforcers. The task has demonstrated convergence with similar discounting measures (i.e., adjusting amount procedure; $r = .67$, $p < .001$; Koffarnus & Bickel, 2014).

Data Analysis

Preliminary data analysis began with visual analysis of collected demand data. Application of exclusionary protocol resulted in data that, at the individual and aggregate level, demonstrated the negatively decelerating monotonic function prototypical of demand task responding. I then assessed raw responses to generate intensity (i.e., likelihood of opt-in at free price), *observed* O_{max} (i.e., greatest reported expenditure calculated as the product of price, average per person annual kWh consumption, and number of household members, multiplied by likelihood of enrollment reported at that respective price point), *observed* P_{max} (i.e., household-specific price corresponding with O_{max}), and breakpoint (i.e., greatest household-specific price at which purchasing is reported). I then fit the data at both the individual level and at the aggregate using Hursh and Silberberg's (2008) exponential demand model, which states:

$$\log Q = \log Q_0 + k(e^{-\alpha (Q_0 C)} - 1) \qquad (1)$$

where Q is consumption at price C, Q_0 is consumption at free price, α is a free parameter describing the sensitivity of the consumer to increasing price (i.e., rate of change in elasticity across the best-fit curve), and k is a nudging parameter conceptualized as range of observed consumption in base-10 logarithmic units. In this case, I allowed Q_0 to freely vary between 0 and 100 (given that this is a likelihood task, Q cannot exceed these values) and k was set to a value of two (i.e., the base-10 logarithmic equivalent of 100). Fitting data at the aggregate level provided a calculable unit elasticity (i.e., *derived* P_{max}), generated using the Lambert transformation of the first derivative of Equation 1 as described by Gilroy and colleagues (2019; see also Gilroy et al., 2020; Watson & Holman, 1977). I calculated price of maximum likely expenditure (i.e., *derived* O_{max}) as the product of derived P_{max} and the probability of enrollment reported at that respective price point.

Data orderliness. I performed data exclusions based on two aspects of subject responding. First, I removed data reflecting a failed response to an attending check built into the task (i.e., set the slider to 50%). I then checked data for systematicity using criteria identified by Stein and colleagues (2015). More specifically, participants were removed for displaying violations of bounce ($B >= 0.10$, trend ($\Delta Q >= 0.025$), reversal from zero (>=1 reversal), or a combination of these criteria.

Experiment 1

The purpose of Experiment 1 was to evaluate a novel hypothetical purchase task for home utilities as a measure of intention to engage in “green” decision making. More specifically, I aimed to evaluate several facets of the task, including (1) data consistency via examination of systematicity and relations among output demand metrics (i.e., less than 20% of collected data flagged for non-systematicity; correlations reminiscent of extant literature), (2) concurrent validity as compared to a previously validated field measure of ecological concern (e.g., NEPS), and (3) predictive validity as it relates to self-reported pro-environmental behaviors reportedly enacted within the respondents' immediately preceding 30 days.

Method

Participants

I recruited for Experiment 1 using the same approach as described in General Methods. Following application of exclusionary criteria (see below), the final sample contained 125 complete datasets. Table 1 describes the average collected demographic. Of the respondents, 49 (45.6%) self-identified as female, 109 (87.2%) self-identified as White, 54 (43.2%) self-identified as politically Democratic, and across respondents, the average age was 38.75 years (*SD* = 12.1) and the average income was $62,216 (*SD* = $38,358).

Materials and Procedure

Survey design and accompanying materials were as described in General Methods, with some notable differences.

eHPT. The novel electricity purchase task was presented such that, at each price point, participants made decisions as to whether they would *opt into* a 100% renewable source of energy. Participants made these choices with the explicit knowledge that their typical energy supply options at expected prices were still available. However, these options were not directly described nor were any competing prices displayed. Responding on the task was recorded using a visual analogue sliding scale ranging in value from 0% (i.e., "Definitely would not") to 100% (i.e., "Definitely would").

"Green" decision making. To better identify respondents invested in everyday pro-environmental decision making and evaluate the predictive ability of the novel task, I presented participants with a list of behaviors indicative of ecological concern (e.g., "Shut off electrical appliances when not in use.") previously employed in work by Schmitt and colleagues (2018). All behaviors were identified as having "non-trivial contributions to climate change mitigation…" (p. 133) and were used in previous work intended to evaluate the relation between pro-environmental behavior and life satisfaction (Schmitt et al., 2018). In the present work, I prompted participants to indicate from among the 39 behaviors any they had demonstrated *at least once* within the preceding 30 days.

Social and Economic Conservatism Scale. To provide additional data on political ideology, respondents completed the 12-item Social and Economics Conservatism Scale (SECS) which assesses disposition toward topics of political debate (e.g., welfare benefits; military and national security) via responding on a 100-point sliding scale (Everett, 2013). Scores are averaged across topics to yield a mean disposition toward these political topics, where higher scores are indicative of more conservative outlooks. The measure has demonstrated a strong correlation with self-reported conservatism ($r = .71$, $p < .001$) and with scores on previously validated measures of political ideology (e.g., Right Wing Authoritarianism, $r = .76$, $p < .001$; Everett, 2013). Data here collected demonstrate adequate consistency ($\alpha = .77$).

Data Analysis

The general statistical approach was as described in General Methods. As a preliminary measure of eHPT performance, I assessed the relations within task demand metrics using a Pearson correlation. To evaluate the concurrent validity of the task, I used an additional Pearson correlation to measure the correspondence between purchase task responding and that of the NEPS. I then used a hierarchical linear model to determine the ability of eHPT responding to predict participants' self-reported willingness to engage in eco-friendly practices (as measured via Schmitt et al.).

Data orderliness. I performed data exclusions as in General Methods. Notably, because data were collected on a sliding scale, exceptions were made in the exclusion of nonsystematic responding. Reversals from zero were tolerated so long as subsequent values did not exceed one. Additionally, I retained datasets which did not demonstrate any change in trend (i.e., did not exceed zero at any price or remained at near-100 levels across all price points).

Results and Discussion

Of the originally collected 218 complete datasets, 65 (29.8%) were removed for failing an attending check built into the novel eHPT (i.e., set the slider to 50%; a conservative approach to attending as many participants may have attempted and failed to set the slider to the appropriate mark due to technological limitations), yielding 153 usable responses. Application of criteria outlined by Stein and colleagues resulted in the additional flagging and exclusion of 28 (18.3%) datasets. Of these, 15 were removed for demonstrating violations of bounce, three for demonstrating violations of trend, two for demonstrating reversals from zero, and eight for some combination of these criteria. Of those flagged but retained, three demonstrated reversals from zero wherein the reversal value did not exceed a reported probability of one, and three did not demonstrate any change in trend. Given the relatively low rate of exclusion based on systematicity, the task appeared to show an acceptable degree of clarity and face validity.

Figure 1 displays aggregate reported likelihood fit with Equation 1. Table 2 displays generated demand metrics. Table 3 displays relations within generated indices and with sum scores on the NEPS. The results are consistent with extant literature in their depiction of a generally volatile set of relations (for instance, the lack of observed relation between P_{max} and Q_0

compared to the strong relation between O_{max} and P_{max}; see Chase et al., 2013). The relatively weak relation only between Q_0 and NEPS sum scores is troubling. That willingness to enroll in an eco-friendly energy supply at free-price is the solitary metric demonstrating congruence with an established measure of ecological awareness suggests—to me—two possible circumstances: (1) my task is measuring a construct conceptually different from that of the NEPS, and/or (2) individuals' concern of matters of ecological relevance does not extend beyond the easily or cheaply accomplish. Further research is needed to unpack this finding.

Table 4 displays the parameters generated by the regression model. My model was constructed to control for location (i.e., zipcode), political ideology (as measured via the SECS), and monetary discounting (i.e., *k* parameter as measured by Koffarnus & Bickel, 2014), while using Q_0, α, observed O_{max}, and breakpoint as predictive variables of interest. Predictors of interest failed to improve the fit of the model beyond my control variables, further supporting the notion of disconnect between the construct measured via eHPT and that of the "green" decision making task list. The behaviors of this list are those which are typically free or low-cost, so I may also lend support to the prospect of eco-friendly practice as being highly sensitive to price imposition.

Overall, the results of Experiment 1 provide reasonable expectation that the eHPT can perform adequately when applied to a sample of similar diversity. The task demonstrated acceptable internal consistency and produced responding that was relatively subdued with respect to nonsystematic responding. The relation revealed between Q_0 and NEPS scores suggests that, without imposed cost, those with greater ecological concern are also those more likely to enroll in "green" energy sources. More research is required to determine the correspondence between decision making at escalating cost and the construct of ecological concern as measured by NEPS responding. Further, the inability of eHPT demand metrics to reasonably predict willingness to engage in "green" decision making suggests some potential conceptual disconnects between typically framed eco-friendly practice and that measured via the present task. Namely, the commodities of interest appear functionally different. The present task is measuring explicitly decisions as they pertain to purchases of energy supply. Such is not a good presented by either the NEPS or the measure of "green" participation. The eHPT additionally presents an extended timeframe without direct termination criteria, so responding should be interpreted through a lens of skepticism. Future research should seek to address this limitation of cross-commodity assessment.

Despite the potential separation of measured constructs, the task serves as a potential mechanism viable for evaluating the efficacy of environmental modifications aimed at eco-friendly choice. Next steps should examine the sensitivity of the task to detect differences in intention to engage in eco-friendly practice as a function of nudging interventions (see Experiment 2). Establishing an ability to better evaluate the efficacy of various treatment approaches to produce greater buy in for a commodity such as renewable energy has vast potential to inform future policy.

Experiment 2

The purpose of Experiment 2 was to assess the sensitivity of the eHPT to differences in intention to engage in eco-friendly practices based on the introduction of a nudge-type environmental modification.

Method

Participants

I recruited for Experiment 2 using the same approach as described in General Methods. Following application of exclusionary criteria (see below), the final sample contained 104 completed datasets. Table 5 describes the average collected demographic. Of the respondents, 37 (35.6%) self-identified as female, 83 (79.8%) self-identified as White, 41 (39.4%) self-identified as politically Democratic, and across respondents, the average age was 39.26 (*SD* = 12.04) and the average income was $54,981(*SD* = $37,394).

Materials and Procedure

Survey design and accompanying materials were as described in General Methods, with notable difference.

eHPT. I randomly distributed respondents into one of two versions of the previously trialed eHPT. The first contained standard wording reflective of that completed in the previous task iteration (i.e., how likely would you be to *opt into* the "green" energy supply; *n* = 54 after exclusion). Participants could instead complete a version of the task in which they reported the likelihood they would *opt out* of the renewable energy source at each price point (i.e., assumption they were automatically enrolled in the alternative with the option of self-removal), in favor of their typical energy supply (*n* = 50 after exclusion). As such, for this condition the typical 15-price array is reinterpreted as the expense paid for electricity should the consumer choose *not* to opt out.

Data Analysis

The general statistical approach was as described in General Methods, with notable exception. I transformed likelihood values reported for the *opt-out* group to their inverse (i.e., difference of 100 and the reported opt-out likelihood) to yield a value indicative of likelihood of remaining enrolled at each escalating per kWh price. Best-fit curves of group aggregates—fit using Equation 1—were compared using an extra sum-of-squares *F*-test to evaluate presence of a systematic deviation in responding. I then compared demand metrics – in this case α, observed O_{max}, and breakpoint – between groups using an independent-samples Wilcoxin Signed-Ranks Test to determine if the verbal manipulation was alone sufficient to produce differing demand.

Data orderliness. I performed data exclusions as in General Methods. Exceptions to the recommendations of Stein and colleagues were as described in Experiment 1. To best accommodate the widest range of varied responding, I excluded calculated O_{max} and P_{max} values of greater than $10,000 from subsequent analyses (thought to represent nonsensical responding in the greater context of the task).

Results and Discussion

Of the originally collected 203 completed datasets, 82 (40.4%) were removed for failing the programmed attending check (i.e., set the slider to 50%) yielding 121 usable responses. Application of criteria outlined by Stein and colleagues resulted in the flagging and exclusion of an additional 17 (14%) datasets. Of these, four were removed for demonstrating violations of bounce, five for demonstrating violations of trend, one for demonstrating reversals from zero, and seven for some combination of these criteria. An additional three calculated O_{max} and corresponding P_{max} values (2.9%) were excluded for exceeding the predetermined threshold.

Aggregate likelihood values reported across conditions, fit with Equation 1, are displayed in Figure 2. Aggregate likelihood values reported within each condition, fit with Equation 1, are displayed in Figure 3. Relevant demand metrics are displayed in Table 6. Generated curves fit the data well with R^2 values for the full set, opt-in, and opt-out conditions of .959, .977, and .873, respectively. A comparison of generated curves via application of an extra sum-of-squares *F*-test revealed a statistically significant difference, $F[2, 26] = 34.52$, $p < .0001$, suggesting a meaningful deviation in reported demand exhibited by group conditions. Comparison of derived demand metrics revealed notable differences in reported electricity purchasing based on group status. Specifically, the opt-out group demonstrated significantly smaller α values (*Mdn* = 0.0128) as compared to the opt-in group (*Mdn* = 0.0250), $z = 873$, $p = .007$. Analysis revealed no between-group differences in maximum expenditure ($z = 1419$, $p = .317$) or breakpoint ($z = 1465$, $p = .451$).

The present study serves two primary purposes in extending the literature. First, the demonstrated introduction of a nudge procedure using the novel eHPT provides an initial application of the task toward policy evaluation. That the task was sensitive enough to detect differences in between-group responding based on the presence of a minute wording change (i.e., opt-in versus opt-out) suggests potential viability for larger scale use in future investigation. More research should be conducted to determine the consistency and durability of said testing framework across a range of differing interventions. Second, the task revealed what appears to be a significant difference in rates of clean energy buy-in based solely on a nudge-type intervention with enormous scaling potential. Participants told they were already enrolled in the clean energy supply, albeit at greater costs than their typical supply, were more likely to remain enrolled when compared—price for price—to those asked to enroll via the opt-in vignette. Future efforts should seek to rigorously evaluate this effect for potential roll-out to community scale.

A leading limitation of the current approach is the difficulty in interpreting the derived demand metrics and in making comparisons between respondents, due in part to the complexity of likelihood responding (i.e., O_{max} being a product of price per kWh, household residents, average kWh usage, and reported likelihood at each price point). Further, the present task instructed participants to indicate on a sliding scale the likelihood they would be willing to pay for the novel electricity at escalating prices. Some concern may surround the validity of such a response, particularly in comparing absolute values (e.g., 48% versus 52% likely) or inherent response bias; this may present additional complications when seeking to evaluate other, potentially simpler nudge-type interventions. Next steps for the present task might include a reconfiguration of subject responding to present a greater array of potential investigatory avenues.

Experiment 3

The purpose of Experiment 3 was to investigate the viability of a reconfigured eHPT—one with a simpler, more ecologically valid response mechanism—as an evaluative measure of intentions to engage in "green" decision making. A primary objective was to determine the extent to which the previously employed sliding scale introduced response bias (e.g., left/right bias). Because the currently presented modified format prevents calculation of most demand metrics at the single-subject level, I sought to evaluate a single index—breakpoint—in its relation to a previously validated measure of ecological concern. I then compare this metric and the best-fit curves between groups as a measure of the effect of side bias—another simple environmental modification—on decision making.

Method

Participants

I recruited for Experiment 3 using the same approach as described in General Methods. The final sample contained 171 usable data sets. Table 7 describes the collected demographic. Of the respondents, 66 (38.6%) self-identified as female, 143 (83.6%) self-identified as White, 86

(50.3%) self-identified as politically Democratic, and across respondents, the average age was 34.96 (*SD* = 10.85) and the average income was $62,540 (*SD* = $102,903).

Materials and Procedure

Survey design and accompanying materials were as described in General Methods, with notable difference.

eHPT. I provided respondents of Experiment 3 the same vignette and assumption as described in the General Method. Participants then progressed through a series of survey pages, each of which contained a single per kWh price from the array and with pages displayed in ascending order according to price. I instructed subjects to respond with a dichotomous yes/no choice in response to the question, "Would you opt into the alternative source of fuel at this price?" Following any breakpoint response by a respondent (i.e., selecting "no"), the task was terminated. To control for and investigate the role of left/right bias as a modulator of reported demand, I randomly distributed participants into groups differing solely in the placement of the terminal response on the survey page. That is, for the left-bias group (*n* = 85 after exclusion), the "no" response was always placed on the left side of the screen (with the opposite being true for the right-bias group; *n* = 86 after exclusion).

Data Analysis

The general statistical approach was as described in General Methods, with notable exception. I coded dichotomous responding at each price point to a corresponding likelihood value (i.e., "yes" = 100%, "no" or any price point beyond breakpoint = 0%) and averaged across groups. I compared breakpoint values to scores on the NEPS measure to determine correspondence between expenditure reported on the modified eHPT and general ecological concern. I then fit group choice aggregates for each per kWh price using Equation 1 and compared using an extra-sum-of-squares *F*-test to probe the presence of group deviation in responding. To further evaluate the presence of group differences, I conducted an independent-samples Wilcoxin Signed Ranked Test using breakpoint as a primary index of interest.

Results and Discussion

Examination of relations among reported breakpoint values and NEPS sum scores failed to reveal a statistically significant relation, $r = -.021$, $p = .806$. Aggregate likelihood values reported across conditions, fit with Equation 1, are displayed in Figure 4. Aggregate likelihood values reported within each condition, fit with Equation 1, are displayed in Figure 5. Table 8 displays relevant demand metrics. Generated curves fit the data well with R^2 for the full set, left-bias, and right-bias conditions of .969, .945, and .978, respectively. A comparison of generated curves via application of an extra-sum-of-square *F*-test failed to reveal a statistically significant difference between curves, $F[2, 26] = 2.604$, $p = .09$. Further comparison of group responding via an independent-samples *t*-test failed to reveal a statistically significant difference, $t(138) = 0.857$, $p = .393$.

The results here reported, although limited in nature, do show some initial promise for the use of a modified eHPT for further evaluation of nudge procedures. That task responding demonstrated limited overlap with ecological concern as measured by the NEPS further supports the notion drawn in Experiment 1 – the eHPT is measuring a different phenomenon related to sustainable living, and thus lends a new conceptual framework from which to examine “green” consumerism. Further research should seek to evaluate relations between a modified eHPT and measures more consistent with the behavior of interest (i.e., purchasing electricity).

A difference in responding based solely on response positioning posits a potential avenue for further nudge research, but in the case of the present study, the manipulation itself simply may not have been enough to promote differing responses. The congruence in responding between the left-bias and right-bias groups does, however, lend confidence to the construction of the task. More specifically, responding appears consistent regardless of the placement of terminal responses, thusly providing support for the robust nature of the assessment. Future research should seek to more thoroughly evaluate the sensitivity of the modified eHPT to detect differences in responding as influenced by simple nudges, perhaps through implementation of more tangible or explicit manipulations. As an added layer, efforts should evaluate oversensitivity of the task to small deviations in administration, as in the placement of a terminal response, and the potential for contamination during proposed community intervention evaluation.

General Discussion

The current sequence of studies presents and evaluates a novel hypothetical purchase task as a measure of and framework for testing interventions upon willingness to engage in “green” consumerism, in this case procuring home electricity supply. Early results show promise for the application of the task as a proof-of-concept use of a hypothetical purchase task to begin investigatory work in the area of policy evaluation. Despite the relatively narrow range of assessment—solely home-energy use behavior—the internal consistency of the gathered data and preliminary demonstration of sensitivity to nudge effects are thought likely to generalize to other tasks of similar nature.

The results of Study 1 exhibit the systematicity of data collected via task administration and correlation among generated demand metrics. These findings align with extant literature examining similar features of novel choice tasks. For instance, the extent of exclusion due to nonsystematic responding (i.e., < 20%) falls well within the expectation of even atypical task administration (e.g., mixed price sequencing, see Amlung et al., 2012; Salzer et al., 2020). Further, in their examination of alcohol purchase task responding, MacKillop et al. (2010) observed comparable relations among output metrics, particularly between O_{max} and Q_0 and between O_{max} and α. Aston et al. (2015b) similarly revealed correlations among these metrics. Of interest, however, is the apparent disconnect between α and the other demand indices of interest (beyond the expected inverse relation between α and Q_0, given that the latter partially designates the range of consumption and former is a measure of sensitivity of price to consumption). That sensitivity of price is roughly independent of other metrics suggests consumption may have been sensitive to factors beyond the employed price structure. Despite best intentions to simulate real-world antecedent stimuli in the choice framework (i.e., the online utility website), some of the employed language may have served as a deterrent to participant enrollment. I offer the following respondent's general survey comment as an exemplar of such effect: "If given the choice, I definitely wouldn't be choosing a company that refers to customers as family, and pretending to care, and all that nonsense. Emotional manipulation in advertising tends to point to lesser quality products and services at inflated prices."

The success of the applied nudge in Study 2 in producing deviation in reported likelihood of purchasing supports a fruitful avenue for pursuit. To my knowledge, this is the first behavior analytic study to demonstrate the effects of an opt-in/opt-out paradigm on decision making. Such a showing is thought to be consistent with existing literature in the domain of choice architecture. For example, Ebeling and Lotz (2015) showed that an opt-out scenario produced far greater rates of enrollment in a clean energy supply over a standard opt-in approach. Pichert and Katsikopoulos (2008) showed that default enrollment was successful in yielding greater buy-in to more expensive clean energy sourcing. Broadly, the minimalism of the employed nudge and significance of the outcome align with current literature in choice architecture. Behavior analysts should continue to view choice architecture as a tool for use in producing greater clinical outcomes and yielding more socially desirable decision making. Greater examination of these tools could prove promising as a policy-mandated default setting for those prospectively enrolling with a new energy supply company.

The results of Study 3 indicate the utility of a potentially more ecologically valid response in application of the eHPT. The lack of observed difference between the left and right-bias groups infers a dynamic task that can be used with versatility depending on the circumstances required. For instance, the focus upon simple and dichotomous responding might lend itself as desirable for a brief and rapid administration more tolerable when attached to a greater battery of surveys or included in real marketing schemes (as in use by utility companies). Further examination of tasks emphasizing ease of use might be a fruitful step in procuring greater adoption of operant choice tasks by those outside of field affiliation (e.g., industry).

The application of a hypothetical purchase task to the area of "green" consumerism is a relatively novel area of investigation. The present study advances upon existing work in a number of ways. To my knowledge, this is the first application of a hypothetical purchase task to the commodity of home energy supply. Interfacing the two frameworks required significant modifications be made to the typical purchase task framework (i.e., that outlined by Roma et al., 2016). I necessarily reinterpreted operant demand metrics to account for the varying expenditures respondents could expect based on the unique kWh usage of their household. As such, the prices displayed to each participant were distinct to their individual experiences. To my knowledge, no such behavior analytic nor operant demand study has thus far been designed in this manner.

As a novel approach to examining "green" consumerism, the current task employed a virtual setting which incorporated a number of what I believe to serve as natural antecedent stimuli for the decision making under scrutiny. That is, participants were asked to indicate their likelihood of enrolling in a novel energy supply. At the time this study was conducted, web-based utility control panels remain a widely popular choice for managing payments, account modifications, and general contact with one's supply company. Simulation of such a control panel for use in the present task was thought to promote more accurate responding in that much of the typical decision making context is present at the time of task completion. From an experimental standpoint, attempts to retain the natural response—biologically important operants—should be pursued so as to maximize the external validity of the collected data.

Considerable ongoing research in the area of simulated operant demand choice is concerned with the presence or absence of these natural antecedent stimuli at the time of decision making (e.g., employing high-quality images of the commodity in question, Roma et al., 2016; see also Amlung et al., 2012; Becirevic et al., 2017) and the questioned validity of hypothetical decision making tasks. More recently, research has focused on the success of experimental marketplaces, much like an online store, for examining demand for various commodities. Quisenberry and colleagues (2015) present an investigation into the efficacy of a simulated "experimental tobacco marketplace" as a means of measuring demand for nicotine-containing products in a simulated format while retaining the validity of the operant response (see also Bickel et al., 2018; Quisenberry et al., 2017). Broadly, summative results of the simulated marketplace underscore the value of retaining these antecedent stimuli and natural operant responses in producing choice representative of everyday decision making. As such, the present study aids in extending this literature to the novel yet comparable paradigm of utility enrollment.

A number of limitations need be taken into account when interpreting the results of the present studies. Foremost, the choices being made—to report likelihood of enrolling in a home energy supply based on per unit pricing—may be seen as abstract to many. It is worth recognizing the very real possibility that most respondents are only remotely aware of their typical kWh rate of electricity consumption. To be asked to make a choice based on information with minimal salience is likely to yield responding which may not perfectly resonate with actual choice. A leading concern in data interpretation is the potential presence of over or under inflation of decision likelihoods, as well as a potential deviation in responding produced by a knowledge gap between those with intimate understanding of home utility supply and those without such an understanding. Future work might seek to reimagine the present task in such a way that makes use of information with more familiarity to the everyday decision maker.

A leading limitation of any simulated decision making task is the means of data collection—self-report. Participants were responding to any number of stimuli present in the decision making environment, and although efforts were consistently made to match leading research in the area of task validation (e.g., Roma et al., 2016) and provide information of value to the participant, such tasks call into question the ability of participants to accurately predict their own behavior. That said, to date a number of efforts have been made to demonstrate the congruence between choices made via hypothetical tasks and those in the naturally occurring context. For instance, Amlung et al. (2012) asked participants to make hypothetical alcohol purchases using a standard alcohol purchase task format. Respondents were subsequently provided an allowance of real money and asked to make purchases of alcohol at a randomly selected price point. Broadly, choices made on the task reflected those made in-person. Similarly, studies have shown the success of hypothetical task-generated demand metrics in predicting behavior of clinical relevance, including alcohol use (MacKillop & Murphy, 2007) and smoking abstinence (Madden & Kalman, 2010), as well as concurrent validity with existing clinically validated scales (e.g., Murphy et al., 2011; Murphy & MacKillop, 2006; Reed et al., 2016). Efforts in the domain of market and consumer science have found a similar degree of overlap between choices made in real and simulated contexts. Burke et al. (1992) examined supermarket purchases over several months and compared these with decisions made via a simulated choice task. On the average, hypothetical choices are reminiscent of those made in-person, thereby supporting the use of simulated choice tasks for studying consumer preferences. Greater research is needed to provide continually growing evidence for the ability of hypothetical tasks to mimic choice behavior of interest.

Another point to consider is the potential differential effect the presented context-establishing stimuli may have had in stimulating choice. As previously noted, several respondents reported feelings of discouragement or hesitation stemming from the jovial, family-centered tone taken when establishing the decision making environment. Future investigation might consider the role of all present stimuli, regardless of the predicted impact said stimuli might have on choice. More work is needed determine the features that are both contributive and degradative to congruent task responding.

Despite these concerns, use of choice tasks remains opportune for study of difficult-to-observe behaviors that do not lend well to traditional behavior analytic methods (e.g., direct observation), such as those central to issues of sustainability. To date, the behavioral economic operant demand literature focused on commodities of interest to sustainability examines only fuel oil, reusable bags and, now, home energy supply. Given the vast nature of the sustainability crisis, interested researchers will find a fruitful, largely untapped area of investigation for further study via behavioral economic methods. Such investigation is of particular importance for applied behavior analysts given this resolute focus on targets of relatively great social validity. Behavioral economists and behavior analysts need continue to evaluate the ability of purchase tasks to (a) extend to commodities of sustained social validity, and (b) evaluate scalable interventions to modulate choice. As a starting point, next steps might focus on behaviors pertaining to low-meat diets (e.g., willingness to purchase plant-based proteins), high fuel-efficiency vehicles (e.g., willingness to purchase a rechargeable vehicle), or water sustainability/conservation (e.g., willingness to pay water fines).

Indeed, many researchers may be reluctant to move toward use of simulated choice tasks given the direction provided by early establishers of the applied sector (e.g., *behavioral* dimension; Baer et al., 1968). Self-report methods are widely discouraged. Yet in their rejoinder paper (1987), Baer et al. make claims regarding the direction of applied research, stating how twenty years of experience reflects, "At best, …that we need analyses of (a) displaying and explaining problems so as to gain effective use of media, (b) controlling the behavior of those other people who can function as decision makers' constituencies (i.e., lobbying), (c) having or being able to recruit campaign support, and (d) recognizing crises as the setting events when those repertoires will be most effective" (p. 315). To be making an input toward policy development, as suggested by Baer et al., perhaps some adoption of outside-the-box practices is necessary. By ensuring the presence of natural antecedent stimuli—as discussed here—in the construction of simulated tasks, we as a field may well be capable of investigating large-scale social problems and generating the data called for by predecessors without sacrificing the experimental control integral to field campaigns.

Our place on Earth is—at present—in a particularly tenuous place. Immediate and extreme intervention is critical. The field of behavior analysis need now keep up with the ongoing trend in sustainable intervention. Rigorously tested and widely impactful policy is the best way we can at present be making a change. Hursh (1991, p. 391) presents an analysis suggestive of an approach to generating a body of evidence most effective for informing policy development. At the bottom-rungs of this hierarchy are data collection in the human/non-human laboratory and clinical research, thought to feed into an econometric analyses of market behavior. The vast collective of contributive literature from the experimental analysis of behavior has provided a potent set of tools from which we can draw; these efforts form the basis of the tasks here employed (see also Nevin, 2005 for an additional example of how we might draw from the basic laboratory in making forays into policy evaluation). Our demonstrated task represents a single installation of econometric evaluation of market analysis (i.e., consumer preferences toward clean energy), but we need match this with a volume capable of informing robust experimental models reflective of societal action. This will take a collective input of significant magnitude, but we cannot now shy away from the challenge. Through consistent demonstration of outside-the-box application and a vigilant pursuit of behaviors most meaningful in the greater context of sustainable living, we may well help to advance the agenda for all.

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Table 1

Experiment 1 Participant Demographic Characteristics

Demographic	*n*
Gender	
Male	74
Female	49
Nonbinary	2
Estimated Income	
$0 – 24,999	13
$25,000 – 49,999	41
$50,000 – 74,999	34
$75,000 – 99,999	15
$100,000+	22
Ethnicity	
White	109
Black/African American	5
Hispanic/Latino	7
Asian	7
Political Ideology	
Democratic	54
Republican	27
Independent	39

Table 2

Experiment 1 Demand Parameters and Metrics

Curve	Q_0	α	O_{max}[a]	P_{max}[a]	Breakpoint[a]
Aggregate	100.00	.0187	$48.78	$155.71	-
Individuals					
Median	100.00	.0198	$66.66	$93.32	$166.65

[a]Values here depicted are curve-derived for the aggregate and observed for the individual-level. Calculations at the aggregate level were made using the average number of reported household residents (i.e., 2.92 persons).

Table 3

Experiment 1 Correlations Among Demand Metrics and NEPS Sum Scores

	1	2	3	4	5	6
Q_0	-	-	-	-	-	-
α	-.470**	-	-	-	-	-
Breakpoint	-.056	-.148	-	-	-	-
O_{max}	-.144	-.250**	.814**	-	-	-
P_{max}	.008	-.388**	.437**	.673**	-	-
NEPS Sum	.197*	-.097	-.002	-.015	.012	-

$^{*} = p < .05$, $^{**} = p < .01$

Table 4

Experiment 1 Regression Analysis Prediction of Sustainable Behavior: Relevant Values and Output

	B	*SE B*	*b*
Model 1			
SECS	-.094*	.038*	-.216*
Zip code	.516*	.210*	.214*
Discounting *k*	-13.573	8.417	-.142
Model 2			
SECS	-.094*	.039*	-.216*
Zip code	.473*	.211*	.196*
Discounting *k*	-14.266*	8.407*	-.150*
Q0	.153*	.069*	.232*
α	14.875	18.467	.087
O_{max}	.009	.011	.131
Breakpoint	-.003	.007	-.063

* = $p < .05$.

Table 5

Experiment 2 Participant Demographic Characteristics

Demographic	*n*
Gender	
Male	66
Female	37
Nonbinary	1
Estimated Income	
$0 – 24,999	17
$25,000 – 49,999	40
$50,000 – 74,999	24
$75,000 – 99,999	11
$100,000+	12
Ethnicity	
White	83
Black/African American	10
Hispanic/Latino	7
Asian	6
American Indian/Alaska Native	2
Political Ideology	
Democratic	41
Republican	31
Independent	28

Table 6

Experiment 2 Demand Parameters and Metrics

Curve	Q_0	α	O_{max}[a]	P_{max}[a]	Breakpoint[a]
Aggregate	92.52	.0154	$52.51	$181.12	-
Individuals					
Median	100.00	.0157	$84.30	$141.34	$169.98
Opt-in					
Aggregate	100.00	.0188	$43.64	$139.21	-
Individuals (*Mdn*)	100.00	.0176	$71.34	$106.81	$166.65
Opt-out					
Aggregate	87.29	.0120	$66.21	$242.06	-
Individuals (*Mdn*)	100.00	.0129	$106.52	$167.46	$173.31

[a]Values here depicted are curve-derived for the aggregate and observed for the individual-level. Calculations at the aggregate level were made using the average number of reported household residents for the entire collected sample, the opt-in group, and the opt-out group (i.e., 2.66, 2.70, and 2.62 persons, respectively).

Table 7

Experiment 3 Participant Demographic Characteristics

Demographic	*n*
Gender	
Male	105
Female	66
Estimated Income	
$0 – 24,999	37
$25,000 – 49,999	61
$50,000 – 74,999	34
$75,000 – 99,999	21
$100,000+	18
Ethnicity	
White	143
Black/African American	15
Hispanic/Latino	32
Asian	8
American Indian/Alaska Native	3
Political Ideology	
Democratic	86
Republican	46
Independent	36

Table 8

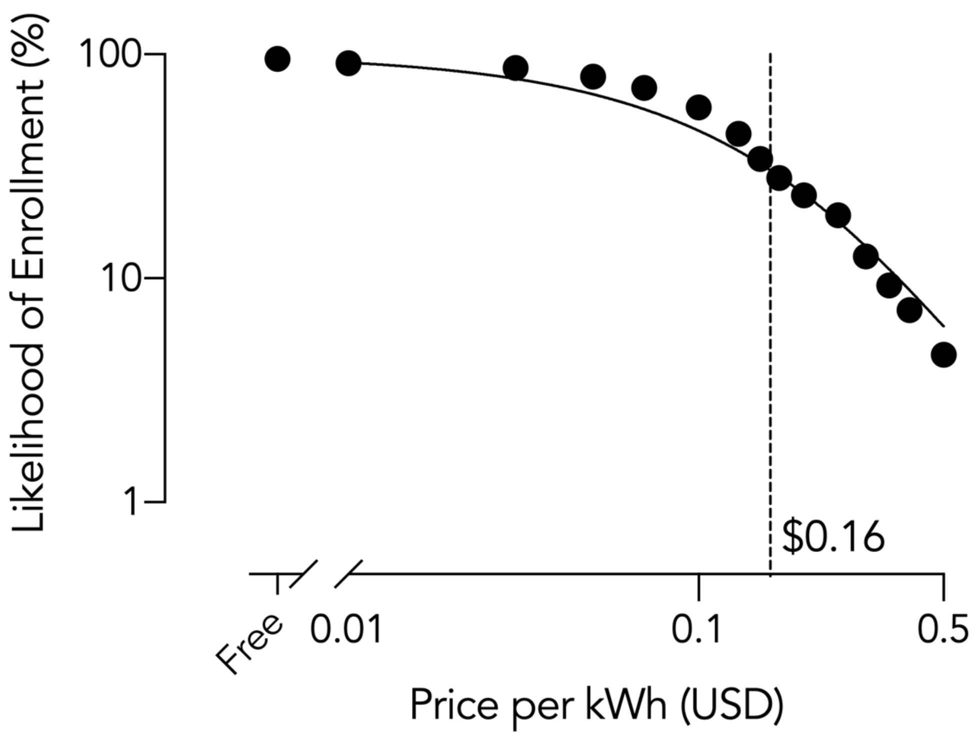
Experiment 3 Demand Parameters and Metrics

Curve	Q_0	α	O_{max}[a]	P_{max}[a]	Breakpoint[a]
Aggregate	73.11	.0259	$43.65	$190.45	-
Individuals					
Median	-	-	-	$39.99	$66.66

[a]Values here depicted are curve-derived for the aggregate and observed for the individual-level. Calculations at the aggregate level were made using the average number of reported household residents (i.e., 3.73 persons).

Figure 1

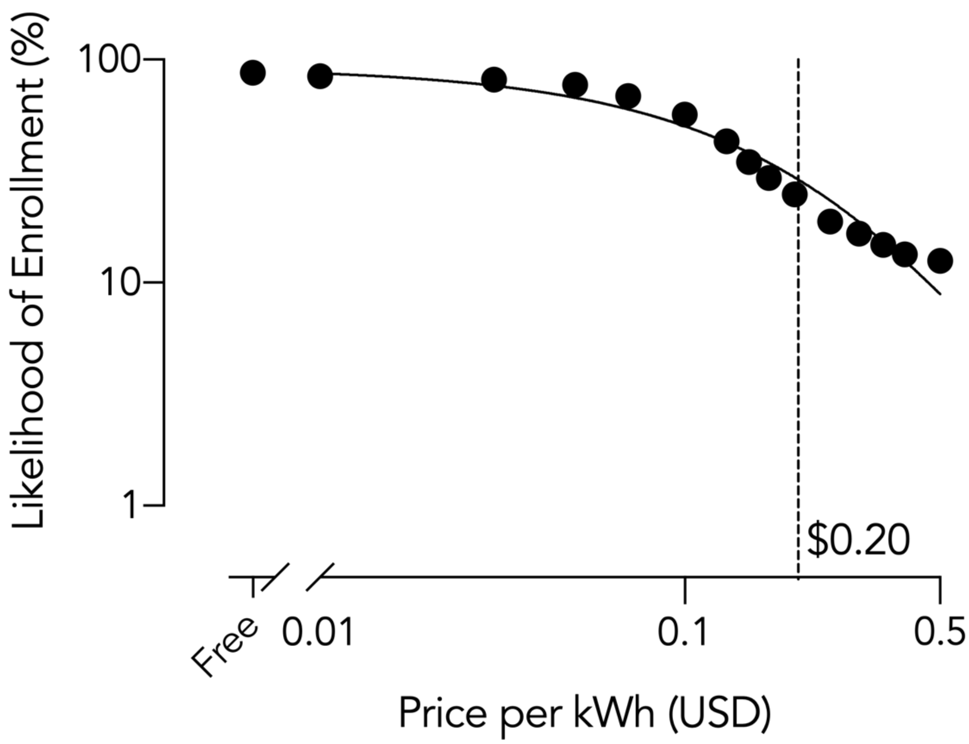
Experiment 1 Average Reported Likelihood of Enrollment as a Function of Price Per kWh



Note. Best-fit curve was generated using Equation 1. Vertical lines represent a derived P_{max} unscaled to individual demographic factors (i.e., # of household residents; see Methods for details).

Figure 2

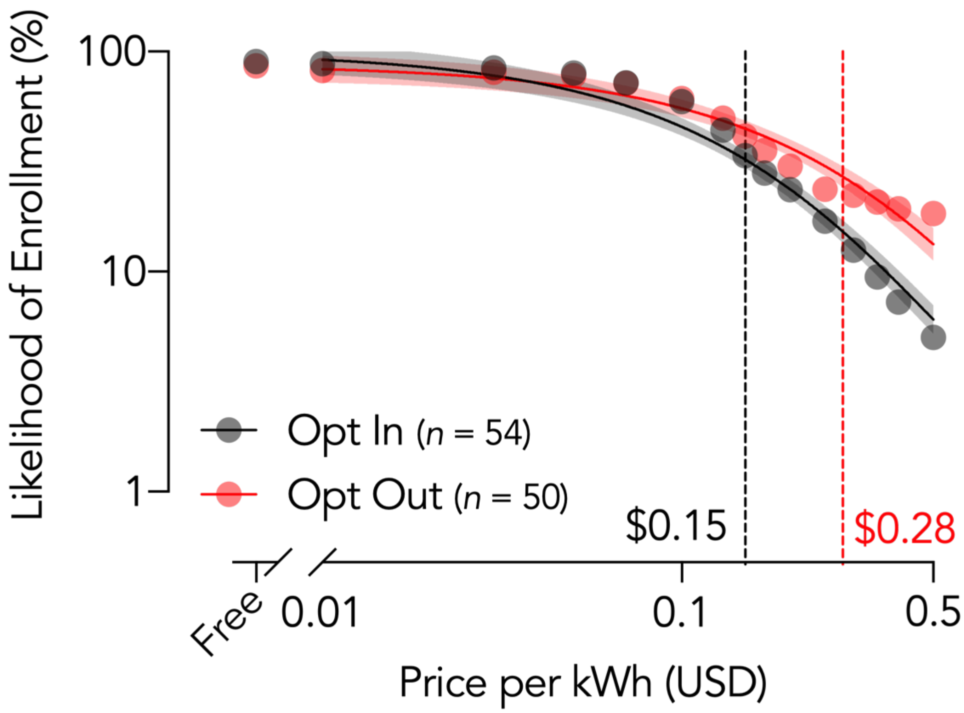
Experiment 2 Average Reported Likelihood of Enrollment as a Function of Price Per kWh Averaged Across Conditions



Note. Best-fit curve was generated using Equation 1. Vertical lines represent a derived P_{max} unscaled to individual demographic factors (i.e., # of household residents; see Methods for details).

Figure 3

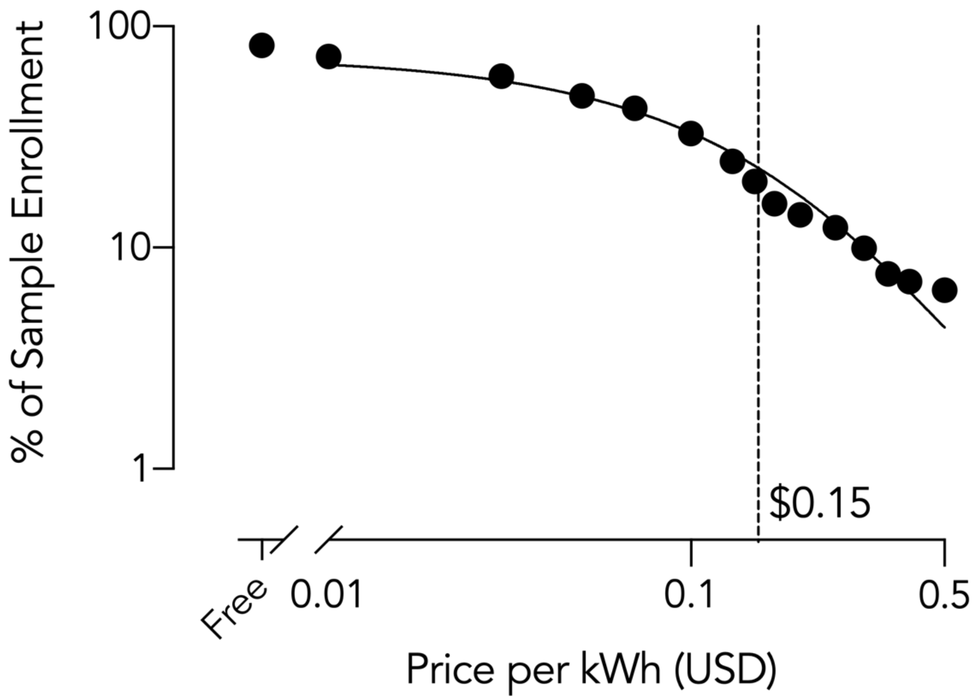
Experiment 2 Average Reported Likelihood of Enrollment as a Function of Price Per kWh Averaged Within Conditions



Note. Best-fit curves were generated using Equation 1. Shaded bands represent 95% confidence interval for generated curves. Vertical lines represent a derived P_{max} unscaled to individual demographic factors (i.e., # of household residents; see Methods for details).

Figure 4

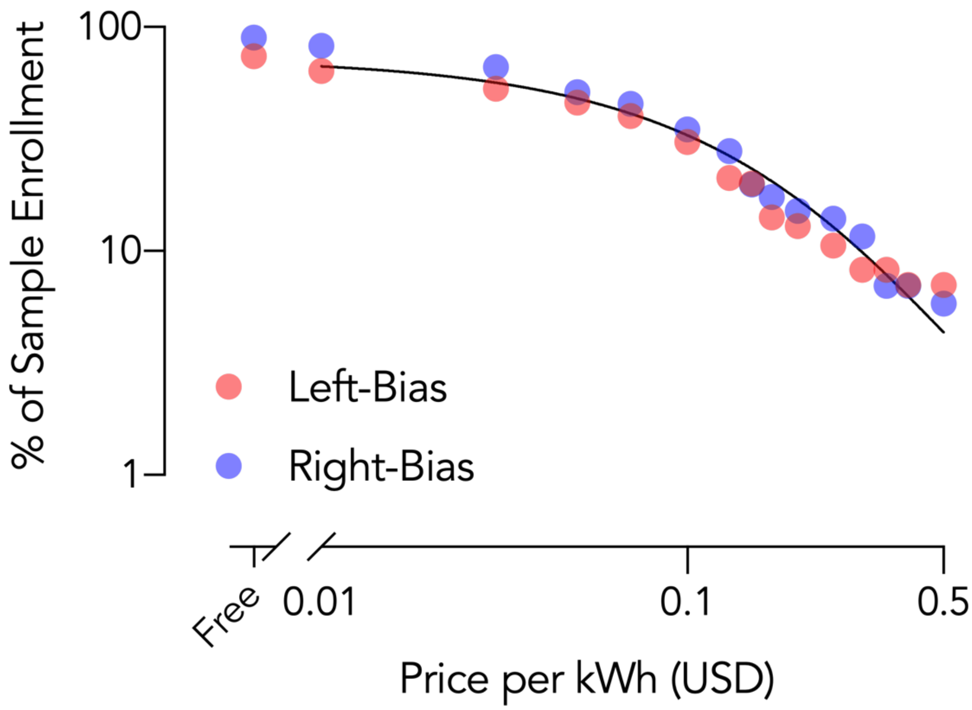
Experiment 3 Average Reported Sample Enrollment as a Function of Price Per kWh Averaged Across Conditions



Note. Best-fit curve was generated using Equation 1. Vertical lines represent a derived P_{max} unscaled to individual demographic factors (i.e., # of household residents; see Methods for details).

Figure 5

Experiment 3 Average Reported Sample Enrollment as a Function of Price Per kWh Averaged Within Conditions



Note. Shared best-fit curve was generated using Equation 1 (see Methods for details).

Appendix A

Informed consent form.

Consumer Valuation of Behaviors and Commodities
Information Statement for Internet Study via Amazon Mechanical Turk

The Department of Applied Behavioral Science at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.

We are conducting this study to better understand consumers' preference for various commodities. This will entail your completion of several surveys. Your participation is expected to take between approximately 15-30 minutes to complete. The content of the survey should cause no more discomfort than you would experience in your everyday life.

Although participation may not benefit you directly, we believe that the information obtained from this study will help us gain a better understanding of how consumers of various demographics value certain commodities or behaviors. Your participation is solicited, although strictly voluntary. Your name will not be associated in any way with the research findings. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission. All data collected will be anonymous. Your responses will be stored in the researchers locked filing cabinet in a locked office space and on password-protected encrypted hard drives. **It is possible, however, with internet communications, that through intent or accident someone other than the intended recipient may see your response.**

Your participation in this study is completely voluntary; however, if you enrolled through the Amazon Mechanical Turk system, you will be compensated with $0.60 in exchange for 30 minutes for a complete and valid survey if approved by the researchers. This is not market research. The information you provide may help scientists develop methods to better understand the processes that influence economic decision-making and choice behavior. These tools and the insights they produce may ultimately provide support for evidence-based policies that can improve public health, safety, and security

If you would like additional information concerning this study before or after it is completed, please feel free to contact us by phone or mail.

Completion of the surveys indicates your willingness to take part in this study and that you are at least 18 years old. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email irb@ku.edu.

Sincerely,

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KU Lawrence IRB # 20635 | Approval Period 2/5/2019 – 2/8/2020

Appendix B

Greeting Text for eHPT Completion.

Welcome to Energy Solutions Plus, Inc., **your new electricity home.**

Our passion is fair and equitable energy. That's why we at *Energy Solutions Plus, Inc.* have partnered with your local supplier to develop a new way to deliver the electricity that powers your world. We're thrilled to have you as a member of our growing family, and we hope you're happy to be with us, too!

It will take some time to incorporate you and your neighbors into our database, so we ask for your patience as we move through this necessary adjustment period. The purpose of today's survey is to collect some background demographic information and determine your preferences for the electricity that keeps you moving.

Please give us a hand in this process by carefully responding to the questions that follow.
If you have any questions at any point during this survey, please make a note of them -- we'll provide an opportunity for comments once we've collected the information we need to update our systems.

Thanks for your cooperation, and again, welcome to the Energy Solutions family!

Appendix C

Demographic and Background Questionnaire

What is your current age?

With which gender do your primarily identify?

- Female
- Male
- Non-binary / third gender
- Prefer to self-describe
- Prefer not to say

Are you Spanish, Hispanic, or Latino or none of these?

- Yes
- None of these

Choose one or more races that you consider yourself to be:

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- Other:

What is the highest level of school you have completed or the highest degree you have received?

- Less than high school degree
- High school graduate (high school diploma or equivalent including GED)
- Some college but no degree
- Associate degree in college (2-year)
- Bachelor's degree in college (4-year)
- Master's degree
- Doctoral degree
- Professional degree (JD, MD)

Which statement best describes your current employment status?

- Working (paid employee)
- Working (self-employed)
- Not working (temporary layoff from a job)
- Not working (looking for work)
- Not working (retired)
- Not working (disabled)
- Not working (other)
- Prefer not to answer

Where are you employed? (If not currently employed, please provide information regarding your most recent employment.)

- PRIVATE-FOR-PROFIT company, business or individual, for wages, salary or commissions
- PRIVATE-NOT-FOR-PROFIT, tax-exempt, or charitable organization
- Local GOVERNMENT employee (city, county, etc.)
- State GOVERNMENT employee; 5-Federal GOVERNMENT employee
- Federal GOVERNMENT employee
- SELF-EMPLOYED in own NOT INCORPORATED business, professional practice, or farm
- SELF-EMPLOYED in own INCORPORATED business, professional practice, or farm
- Working WITHOUT PAY in family business or farm
- Unsure
- Prefer not to answer

Which of the following industries most closely matches the one in which you are employed? (If not currently employed, please provide information regarding your most recent employment.)

- Forestry, fishing, hunting or agriculture support
- Real estate or rental and leasing
- Mining
- Professional, scientific or technical services
- Utilities
- Management of companies or enterprises

- Construction
- Admin, support, waste management or remediation services
- Manufacturing
- Educational services
- Wholesale trade
- Health care or social assistance
- Retail trade
- Arts, entertainment or recreation
- Transportation or warehousing
- Accommodation or food services
- Information
- Other services (except public administration)
- Finance or insurance
- Unclassified establishments
- Prefer not to answer

What is your current postal code?

How many people are living or staying at this address?

Please estimate your **entire household** income (USD$) in 2018, before taxes (enter without comma; i.e., 45000 *not* 45,000).

Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, or something else?

- Republican
- Democrat
- Independent
- Other
- No preference

Some rental agreements include utilities as a perk, such that the average month-to-month expense of utilities is factored into monthly rent payments. Are you (as a household) required to pay for your electric utilities?

- Yes, my household pays for its electricity.

- No, my household does NOT pay for its electricity (for the reason stated above, or similar).

Are you (as an individual) at least partially responsible for paying your electricity bill? (In other words, do you have some involvement in the transaction *beyond* contribution of money e.g., handling bill, mailing in check/making payments, contacting utility company, etc.?)

- Yes
- No

Based on your most recent electricity statement(s), please provide an estimate of your *average* monthly spending on electricity (as a utility in $USD; e.g., if spending $75 per month, enter '75').

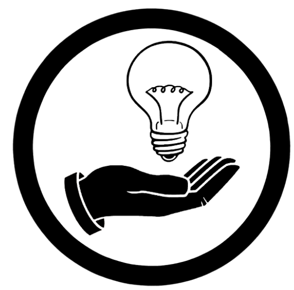
Appendix D

Opt-in Vignette and Assumptions

Please read and consider the following.

As part of the transfer to your *new* electric utility company, you now have the option of receiving **100% renewable energy** via wind-farms in your area. Before we can provide efficient and equitable access to this clean and renewable form of electricity, we'll need to update our pricing system based on the needs and preferences of our customers. You **have not been** automatically enrolled in this program as of now, so standard opportunities for electricity are still available. Remember that more conservative energy use can result in sizable reductions to energy costs.

Electricity consumption includes all household electricity use, which may include (but is not limited to):



- Water heating (as in for showers, etc.).
- Home heating and cooling.
- Large appliance use (e.g., clothes washer/dryer, dishwasher, refrigerator, etc.).
- Lighting and small appliance use (e.g., television, computer, etc.).

The purpose of this exercise is to better understand your preferences for the opportunity described above. The prices that will be displayed represent a series of approximate *per kilowatt hour* (kWh) and monthly costs for the proposed alternative energy source. Monthly fees represent potential fees you might experience after 30 days of *typical* use. Please assume your current financial situation when evaluating each price point. Please also assume that any purchased electricity must be used/consumed within a month (30 days) and is for use only by current and immediate members of your household. As such, electricity cannot be sold or saved (as in battery storage).

Appendix E

Opt-out Vignette and Assumptions

Please read and consider the following.

As part of the transfer to your *new* electric utility company, you now have the option of receiving **100% renewable energy** via wind-farms in your area. Before we can provide efficient and equitable access to this clean and renewable form of electricity, we'll need to update our pricing system based on the needs and preferences of our customers. You **have been** automatically enrolled in this program as of now, but standard opportunities for electricity are still available. Remember that more conservative energy use can result in sizable reductions to energy costs.

Electricity consumption includes all household electricity use, which may include (but is not limited to):

- Water heating (as in for showers, etc.).
- Home heating and cooling.
- Large appliance use (e.g., clothes washer/dryer, dishwasher, refrigerator, etc.).
- Lighting and small appliance use (e.g., television, computer, etc.).

The purpose of this exercise is to better understand your preferences for the opportunity described above. The prices that will be displayed represent a series of approximate *per kilowatt hour* (kWh) and monthly costs for the proposed alternative energy source. Monthly fees represent potential fees you might experience after 30 days of *typical* use. Please assume your current financial situation when evaluating each price point. Please also assume that any purchased electricity must be used/consumed within a month (30 days) and is for use only by current and immediate members of your household. As such, electricity cannot be sold or saved (as in battery storage).

Appendix F

Attending Check Questions

1) I'm being asked to make decisions regarding my purchasing of…
   a. Electricity
   b. Alcohol
   c. Gasoline

   Correct Answer: Electricity

2) In this scenario, I have been automatically enrolled in the alternative energy program.
   a. True
   b. False

   Correct Answer: True (if opt-out) or False (if opt-in)

3) In this scenario, I have access to sources of electricity other THAN the renewable source being marketed.
   a. True
   b. False

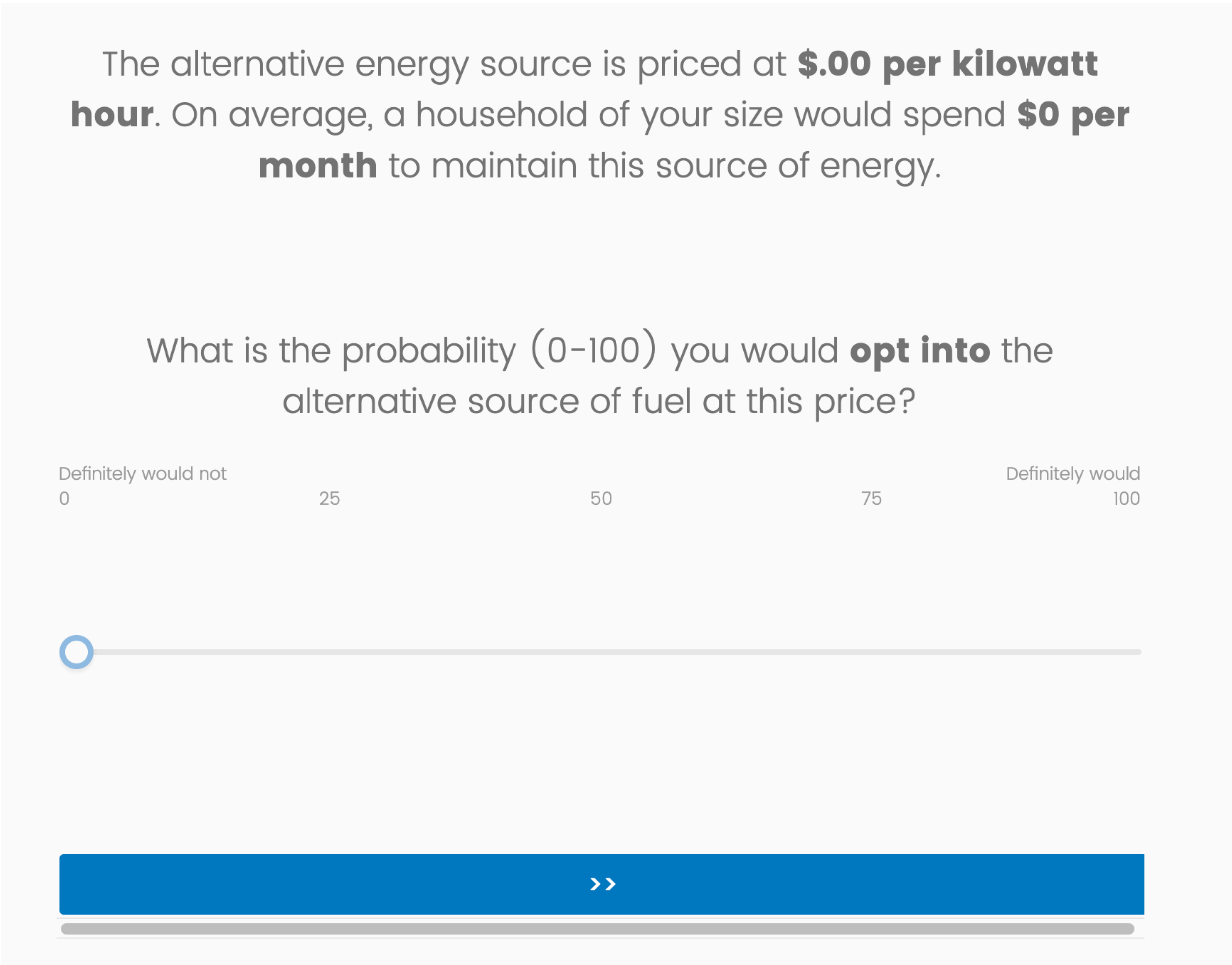
   Correct Answer: True

4) When making hypothetical purchases, I should assume my current financial status.
   a. True
   b. False

   Correct Answer: True

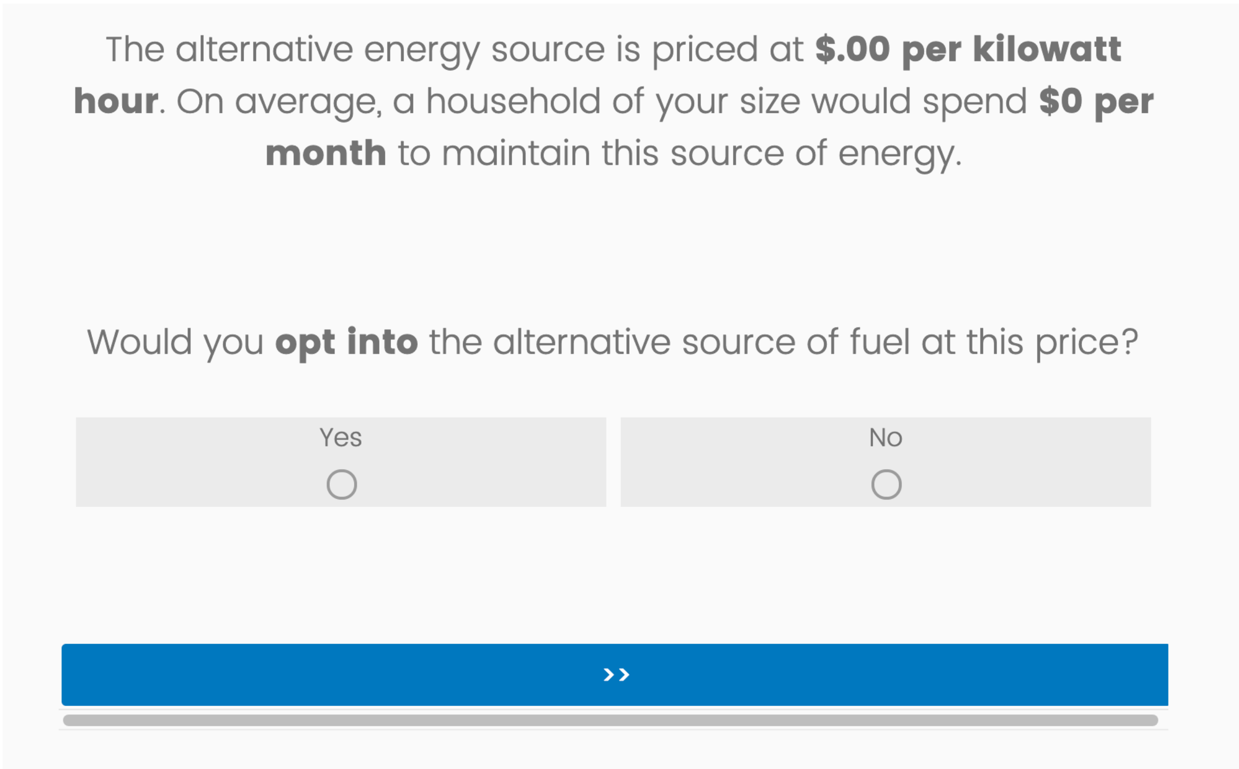
Appendix G

Screenshot of eHPT Slider Response (Opt-in)



Appendix H

Screenshot of eHPT Dichotomous Response (Opt-in; terminal-response right)



Appendix I

Schmitt et al. 2018 Sustainable Behaviors

To better understand the interests of our potential customers, please indicate which of the following behaviors you have demonstrated **in the last 30 days.** Please check all that apply.

- Participate in local environmental activities
- Buy food at a farmer's market
- Talk to children about environmental issues
- Buy locally produced foods
- Buy energy-efficient appliances
- Make your own products instead of purchasing
- Talk to children about how food is grown
- Attend pro-environmental meetings
- Buy environmentally friendly soaps or cleaners
- Buy organic food
- Eat a diet based on organic, local, or free-range food
- Trade of share products with others rather than buy
- Buy products made from recycled materials
- Avoid excess packaging in purchases
- Compost garden or kitchen waste
- Grow your own food
- Walk or cycle
- Support pro-environmental candidates in elections
- Buy an efficient vehicle
- Buy high-efficiency light bulbs
- Use reusable bags when shopping
- Turn off tap when soaping up
- Turn off tap when brushing teeth
- Eat a vegetarian diet
- Minimize number of baths or showers
- Reduce hot water temperature
- Shut off electrical appliances when not in use
- Minimize water use in yard and/or garden
- Reduce home air-conditioning use
- Fix something rather than buy new
- Turn off tap when washing dishes
- Reuse paper or glass
- Hang clothes to dry instead of using dryer
- Buy used products instead of new ones
- Minimize use of home heating
- Turn off lights when not in use
- Use recycling bins for paper, cardboard, cans, and/or glass

- Run washer/dryer only when full
- I have not engaged in any of these behaviors

Appendix J

New Ecological Paradigm Scale

Listed below are statements about the relationship between humans and the environment. For each item, please indicate your agreement with the statement.

Do you agree or disagree that

We are approaching the limit of the number of people the Earth can support.
- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Humans have the right to modify the natural environment to suit their needs.
- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

When humans interfere with nature it produces disastrous consequences.
- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Human ingenuity will insure that we do not make the Earth unlivable.
- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Humans are seriously abusing the environment.
- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

The Earth has plenty of natural resources if we just learn how to develop them.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Plants and animals have as much right as humans to exist.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

The balance of nature is strong enough to cope with the impacts of modern industrial nations.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Despite our special abilities, humans are still subject to the laws of nature.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

The so-called "ecological crisis" facing humankind has been greatly exaggerated.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

The Earth is like a spaceship with very limited room and resources.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Humans were meant to rule over the rest of nature.

- Strongly agree
- Mildly Agree

- Unsure
- Mildly Disagree
- Strongly disagree

The balance of nature is very delicate and easily upset.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Humans will eventually learn enough about how nature works to be able to control it.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

If things continue on their present course, we will soon experience a major ecological catastrophe.

- Strongly agree
- Mildly Agree
- Unsure
- Mildly Disagree
- Strongly disagree

Appendix K

Social and Economic Conservatism Scale

For the following questions, please rate on the thermometer how positive or negative you feel about each issue on a scale of 0 (zero) to 10, where 0 (zero) represents very negative and 10 represents very positive.

Abortion (0-10)

Welfare benefits (0-10)

Limited Government (0-10)

Military and national security (0-10)

Religion (0-10)

Gun ownership (0-10)

Traditional marriage (0-10)

Traditional values (0-10)

Fiscal responsibility (0-10)

Business (0-10)

The family unit (0-10)

Patriotism (0-10)