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Measuring household energy efficiency behaviors with attention to behavioral plasticity in the United States

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ABSTRACT

Household energy consumption remains ripe for behavioral intervention, being responsible for an estimated 31% of U.S. CO_2 emissions. As researchers attempt to understand the factors that influence household energy efficiency behaviors, we suggest it is important to attend to behavioral plasticity—how the perceived difficulty of behavioral responses varies across individuals, behaviors, and contexts. We present a new instrument composed of behaviors identified in previous analyses as having the highest impact on residential energy consumption. Our instrument allows for the specific measurement of self-reported behaviors, behavioral intentions, and inability to perform behaviors. Results from a convenience sample of 1522 U.S. adults demonstrate the construct validity of this instrument, as key factors known to influence pro-environmental behaviors—e.g., key environmental beliefs and attitudes—predict household energy efficiency behaviors.

1. Introduction

Individuals and households perform behaviors that affect the environment in their roles as consumers, as citizens, and—for some—as activists [1–5]. Researchers and policy-makers are renewing attention to consumer behaviors given their potential contribution to reducing energy and climate problems [6]. For example, direct energy consumption by U.S. households is responsible for about 31% of national CO_2 emissions or about 8% of global emissions [7]. Thus, household energy use represents a large efficiency target. Sound energy efficiency policy could reduce overall U.S. emissions by about 7.4% and help households achieve savings with little or no lifestyle change [7]. Yet a gap between what is possible and what is realized remains. Understanding the reasons for this gap, and identifying effective strategies to reduce it, is a high priority for research [3,6,8–12]. Such research may have the added benefit of providing insights for policies and programs intended to increase efficiency in household use of water and other resources.

One of the major challenges to advancing our understanding of energy consumption is that obtaining data on actual behavior is very difficult and costly. Though new web-based technologies are changing our ability to directly monitor residential energy use, most scholarship still relies on self-reported behaviors and behavioral intentions. Of course, this problem is not unique to the study of energy behaviors; it also applies to most types of environmentally significant behavior, such as water use, and to research on voting or other forms of political activism. For the foreseeable future, much of our research on energy consumption at the household level will depend on self-reported behaviors and behavioral intentions. We should thus be attentive to how we measure them.

In this study, we present a new instrument to measure household energy efficiency behaviors. Our approach acknowledges behavioral plasticity—how the perceived difficulty to act constrains behavioral responses across individuals, behaviors, and contexts [7,13]. The instrument can be used to identify the mix of households that are already performing an efficiency behavior, or those that have not yet performed the behavior but might in the future, while sorting out those (e.g., renters, non-drivers) who cannot perform the behavior because of structural constraints. Looking at behaviors already performed may be particularly useful in understanding the more stable influences on energy consumption, such as structural and social psychological factors. Looking at

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behavioral intentions facilitates the study of potential change and is well suited for use in experiments. The measures we include in our instrument represent half of the behaviors examined in Dietz et al.'s reasonably achievable emissions reduction (RAER) analysis [7], specifically selecting those behaviors calculated to provide the highest potential energy savings over the next ten years. Since RAER was developed with a focus on U.S. households, the instrument would have to be modified for use in other contexts. Yet, we believe that the basic logic—differentiating what is already being done, what individuals feel is not within their control, and the likelihood they will perform a behavior in the future—would apply in many contexts and to a broad array of environmentally significant behaviors.

Our goals are to offer a measurement instrument that other researchers will find useful and to encourage discussion of the best methodologies to measure energy efficiency behaviors, especially in the absence of direct measures. We acknowledge that the best self-reports of current behavior and behavioral intentions cannot replace direct measures of actual behavior, but we believe progress has been and will continue to be made through the use of self-reports. In the next section, we describe our participants and procedures before presenting some initial results with the measures from our new instrument.

2. Methods

2.1. Participants and procedures

We tested our household energy efficiency behaviors instrument (which we discuss at the beginning of Section 3) in an early stage of an experiment examining the influence of different frames on Americans' climate change views. Briefly, we administered a survey via SurveyMonkey to participants we recruited via Amazon Mechanical Turk (MT), a crowdsourcing website where "requesters" solicit "workers" to perform "human intelligence tasks" (HITs) for pay. MT has emerged as a practical way for recruiting a large number of participants from a reasonably wide cross-section of the general public either for online experiments or for testing new instruments [14–18]. To solicit a broad cross-section of research participants, we advertised a HIT titled "Your Attitudes about Important Social Issues in the US."

Our survey was completed by 1522 U.S. residents on December 13–24, 2013. Respondents earned $0.50 for completing the survey, which took slightly less than nine minutes on average. In addition to our household energy efficiency behavior instrument, the survey included standard questions about respondents' demographic, social, and political characteristics as well as questions we used to measure environmental beliefs and attitudes, which we discuss first. To demonstrate the construct validity of our instrument [19], we investigated whether key factors known to influence environmental decision-making—e.g., general environmental beliefs [1,20] and concern about specific environmental problems [21,22]—predict household energy efficiency behaviors while controlling for a set of demographic, social, and political characteristics.

We measured general environmental beliefs with the modified New Ecological Paradigm (NEP) scale [23–25], which uses a 5-point Likert scale ranging from "strongly disagree" = 1 to "strongly agree" = 5. We created an additive scale using Stata's alpha procedure (Cronbach's alpha = 0.85). High scores on the NEP scale indicate strong beliefs that humans are able to disrupt the environment. We measured concern about specific environmental problems [26,27] with the Worry about Environmental Problems scale [28]. Respondents indicated how much they worried ("not at all" = 1, "only a little" = 2, "a fair amount" = 3, "a great deal" = 4) about the following eight problems: pollution of rivers, lakes, and reservoirs; air pollution; damage to the Earth's ozone layer; the loss of tropical rain forests; the global warming or climate change; contamination of soil and water by toxic waste; pollution of drinking water; and extinction of plant and animal species. Again, we used Stata's alpha procedure to produce a scale, with high scores on the Worry about Environmental Problems scale (Cronbach's alpha = .91) indicating great worry about this set of environmental problems.

Table 1 describes the demographic, social, and political variables we used in our analyses. Gender ("female" = 1) and race ("white" = 1) are measured with dummy variables. Rather than assume linear effects, age/cohort is measured with a set of dummy variables ("30–39," "40–49," "50–59," and "60 and older") with "18–29" as the reference category. Education is measured by the highest degree earned: "less than high school diploma or equivalent" = 1 to "graduate/professional degree" = 6. Income is measured as approximate yearly household income: "less than $25,000" = 1 to "$100,000 or more" = 5. Political ideology is measured on a 7-point scale from "extremely conservative" [1] to "extremely liberal" [7], with "moderate" [4] in the middle, and party identification is measured on a 7-point scale from "strong Republican" [1] to "strong Democrat" [7], with "Independent" [4] in the middle. Overall, our sample is more male, younger, more highly educated, and more liberal than a representative U.S. sample.

2.2. Methods of analysis

We analyzed our data in three stages. First, we examined the distribution of responses for each of the energy efficiency behaviors in our instrument. Second, we examined the dimensionality of behaviors already performed and of behavioral intentions using exploratory factor analysis. Focusing on behaviors already performed parallels studies that examine how social psychological and social structural factors influence self-reported behaviors, while focusing on the likelihood of performing behaviors that are still available to be performed is probably most appropriate for studies using experimental interventions to influence behavioral intentions.[1] Third, we assessed the construct validity of our measures by examining how predictors commonly used in the environmental decision-making literature (described in Section 2.1) are related to self-reported behaviors and behavioral intentions. While we report conventional significance levels, since this is a convenience sample, p values are probably best interpreted as a comparison of the effects of a particular independent variable to the potential effects of a purely random variable. We tested for potential problems with collinearity with the variance inflation factor (VIF) statistic and found none; the largest VIF was 2.61, and the average was 1.43, indicating no substantial collinearity. We conducted all statistical analyses using Stata 12.1.

3. Results

3.1. The energy efficiency behaviors instrument

Table 2 displays the items used in our energy efficiency behavior instrument, which is a modified version of an existing measure of

[1] We can imagine other ways of using the data. One option is to focus on the characteristics of respondents who feel constrained, which is likely a function of life course, geographical location, and affluence. Another option is to focus on the mixture of "have already done" and "likely will do" responses to assess the likely future prevalence of a behavior. For this initial analysis, we simply examine self-reported behaviors and behavioral intentions for those available but not yet performed behaviors.