Encouraging pro-environmental behavior: Do testimonials by experts work?

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Abstract

Using behavioral nudges to motivate pro-environmental behavior appeals to program administrators seeking cost-effective ways to increase adoption of environmental practices. However, not all nudges are effective, and reporting when nudges fail is as important as documenting their successes. We used a framed field experiment with 308 adults from the Mid-Atlantic to test the effectiveness of an expert testimonial in encouraging adoption of native plants in residential settings. Though studies have found testimonials to be effective in other contexts, we find that the video testimonial had no effect on residents' willingness to pay for native plants. Our analysis also shows that consumers who are younger, have higher incomes, and use other environmentally friendly practices on their lawns are more likely than other consumers to purchase native plants.

Introduction

Policymakers and program managers are increasingly interested in identifying effective non-monetary behavioral interventions to encourage pro-environmental behavior [1]. Collectively referred to as nudges, these interventions can be attractive because they are inexpensive, relatively simple to implement, and preserve individual freedom of choice [2]. Growing evidence suggests that nudge-style interventions have the potential to motivate energy and water conservation [3–7], improve recycling efforts [8], and reduce nonpoint source pollution [9].

However, gaps remain in our understanding of the effectiveness of specific interventions in motivating pro-environmental behavior [10]. Based on a review of 160 experiment-based studies of environmental interventions, Byerly et al. [10] identified areas in need of future

research to inform the design of policies and programs, including testing the effectiveness of interventions used in other contexts in promoting pro-environmental behavior. Behavioral interventions such as information provision [11], peer comparisons [12], social norms [13,14], and framing [15,16] have been extensively studied. Less is known about testimonials, such as opinions and recommendations, provided by experts and influencers who speak positively about a pro-environmental product or practice.

Several studies have found that testimonials are effective in some contexts [17–19]. In terms of cost-effectively promoting demand for consumer goods [20–25], they have been called the "workhorse selling tool" that never goes out of vogue [20, p 29]. They have also been identified as successful in promoting positive changes in health-related [17,26,27], child safety [28], and mental health [29] behaviors. Testimonials by experts who are seen as credible have been particularly effective in improving the believability of messages [30,31], and several studies have found that audio-visual testimonials are more effective than text and photos [32,33].

A few studies have explored the impacts of testimonial-based interventions on the adoption of pro-environmental behavior. Elgaaied-Gambier et al. [34] and He et al. [35] showed that having an endorser in printed advertisements had a positive impact on the intent of French consumers and students in China, respectively, to choose positive environmental behaviors. Studies that have examined the role of celebrity endorsements have produced mixed results. Olmedo et al. [36] and Ellis et al. [37] found that celebrity endorsements were largely ineffective in inducing pro-environmental behavior, while Ho et al. [38] demonstrated that a celebrity endorsement combined with an information campaign led to a 25% reduction in the use of plastic items among students in Vietnam. These studies provide valuable insights but present challenges when applying their findings to pro-environmental behavior in other countries, such as the

United States. We extend the existing body of knowledge by conducting a revealed preference study of U.S. consumers to test the effect of an expert testimonial on willingness to pay (WTP) for native plants, which offer a suite of environmental benefits when planted in residential landscapes.

An important issue associated with experiment-based studies of behavioral interventions for pro-environmental behavior is the absence of statistical power analyses to determine adequate sample sizes and adequate randomization [10]. The results of other studies, consequently, can be misleading for policymakers and program managers when they fail to detect existing effects and overstate detected effects [39]. Therefore, randomized controlled experiment designs and sufficient sample sizes are needed to establish causal relationships between specific interventions and pro-environmental behavior [10,40].

In this paper, we contribute to the existing literature related to testimonials – broadly defined as opinions and recommendations expressed by experts or influencers encouraging a behavior – by evaluating the effectiveness of an expert testimonial in promoting adoption of pro-environmental behavior using a well-powered randomized experiment design. We test the effect of viewing a video testimonial from an expert on participants' WTP for native plants in an incentive-compatible framed field experiment by recruiting 308 adults from the U.S. Mid-Atlantic region.

Pro-environmental behaviors generally are defined as behaviors that reduce the actors' negative impacts on the environment [41,42]. In this study, we focus on a specific residential pro-environmental behavior – the purchase of native plants. Native plants provide numerous environmental services, including supporting biodiversity [43], and they are an environmentally friendly best management practice for residential landscaping. They require less water and fewer

pesticides and fertilizers than do conventional lawns [44], and reduce losses of biodiversity in urban and suburban landscapes by attracting a wide variety of insects and birds [43]. And, like all plants, they sequester carbon [45] and reduce runoff.

An important feature of our experiment is that it is non-hypothetical, presenting participants with opportunities to purchase native plants for their own use. This design allows us to examine the effect of an expert's video testimonial in an active market setting in which participants exchange real money for real goods, thus revealing their true preferences [46].

Materials and methods

Experiment design

We designed an incentive-compatible single-bounded dichotomous-choice framed field experiment to test the effect of a video testimonial on WTP for Husker Red (*Penstemon digitalis*), a perennial plant native to the U.S. Mid-Atlantic region that was recommended by a native plant expert at the local land grant institution. The experiment, which took approximately 15 minutes to complete, was conducted in April and May 2018 at three locations in the U.S. Mid-Atlantic region – a large community event, a super-regional shopping mall frequented by more than 20 million shoppers each year, and an ice cream shop. The locations were selected because they provided access to a diverse pool of participants.

Signs and flyers were used to recruit potential participants 22 years of age or older who make management decisions about the landscape around their home in a two-part experiment. Prior to making those decisions, each participant was endowed with a $10 participation payment that was theirs to keep – they could also use this money to purchase plants. Participants were then assigned an iPad Pro with headphones after reading and signing a consent statement to

participate in the experiment. Participants completed the experiment asynchronously and were not permitted to communicate with other participants present at the same time. The experiment (control and treatment versions), the choice questions, and a short survey were presented electronically via the iPad screens.

To test the effect of the expert testimonial on their WTP for plants, participants were randomly assigned to either the non-video control group or the video-testimonial treatment group. Before making their WTP choices, they received written information about the benefits of native plants (see Fig 1). Participants in the treatment group viewed the 90-second video testimonial in which the benefits of native plants were described by Dr. Doug Tallamy, a well-known professor of entomology and wildlife ecology at a local land-grant university, who is a highly regarded expert in the field and author of a best-selling book about conservation and landscape ecology. A transcript of the video testimonial and a web link to the video can be found in S1 Appendix A of this paper. In the experiment, participants in the treatment group were required to watch the entire video before they could proceed with the experiment.

Fig 1. Written information provided to participants about the benefits of native plants.

During the first portion of the experiment, participants were given the opportunity to purchase a bundle of three ready-to-plant landscape plugs of Husker Red. The iPads presented participants with a description of the plant and a picture of how it would look once fully grown (see Fig 2). Participants were asked to indicate their willingness to purchase the bundle at a stated price in three dichotomous-choice (Yes/No) questions that presented different prices: $0, $3, and $6 per bundle. We included a free plant bundle ($0 price) decision because the second stage of the experiment, which is not reported here, was designed to analyze how self-reported

plantings were affected by receiving the plants for free versus purchasing them. The prices were presented in random order to avoid potential ordering effects.

Fig 2. Description of the native plant offered to experiment participants.

To ensure incentive-compatibility, participants were told that only one of the three purchase decisions would be binding, and that the binding decision would be randomly selected at the end of the study to determine participants' take-home cash and whether they purchased the native plants. This mechanism ensured that participants' dominant strategy was to answer 'Yes' whenever the posted price did not exceed their maximum WTP for the bundle. After answering the WTP questions, participants completed a short survey that collected information on their socio-demographic characteristics and their lawn care practices.

Once they completed the survey, the program randomly selected one of the prices (decisions) as binding and notified participants of their outcomes. Participants who indicated 'Yes' in the selected decision purchased the bundle of plants at that price, which was deducted from the $10 participation payment; they received the plant bundle and the balance of the participation payment. Participants who indicated 'No' did not purchase plants and received the entire $10 participation payment. As participants exited the experiment area, they returned the iPads and received their take-home funds and plants purchased, if any. A detailed experiment protocol and copy of the survey are provided in S2 Appendix B.

Before conducting the experiment, we performed an ex-ante power analysis to determine the required sample size for the full experiment, which consisted of three treatment arms and two stages (in this paper, we present results of one treatment from the first stage of the experiment). The power analysis was conducted via simulation following the approach described by Feiveson

165 [47] so that we could model the multi-stage structure of the experiment and account for some
166 participants exiting the experiment after each stage. To implement the simulation, we used
167 valuations of native plants collected via an experimental auction by members of our research
168 team [15]. The final experimental design required 345 participants to reliably detect the effect of
169 the video-testimonial on WTP for native plants, assuming a standardized effect size of 0.30 with
170 80% power (i.e., $\beta = 0.80$). Because we obtained data from only 308 participants, we also
171 conducted an ex-post power analysis to understand the implications for our analysis. We present
172 additional details about the ex-post power analysis in the results section.

173 ## Data

174 In the experiment, we collected valid data from 309 participants. One participant was dropped
175 because of invalid data entry, resulting in a final sample of 308 adult individuals. According to
176 participants' self-reported zip codes, about 72.8% of the participants resided in Delaware, 9.1%
177 of the participants resided in Pennsylvania, and 7.4% of the participants resided in Maryland.
178 Table 1 provides summary statistics of the participants' socio-demographic characteristics. On
179 average, participants in the experiment were 41 years old, 44% were male, and 42% had one or
180 more children under 18 years old in their households. Approximately 66% of the participants
181 were employed, and about one-third of the participant households fell into each annual income
182 category: less than $50,000; $50,000 to $100,000; and greater than $100,000. In terms of
183 education, 67% of the participants had undergraduate and/or graduate degrees. Most lived in
184 urban areas (87%) and owned their homes (68%). About 84% of the participants indicated that
185 they used environmentally friendly practices to maintain their lawns.

186 Two sample t-tests showed that the control and treatment groups were balanced in terms
187 of most of the socio-demographic characteristics. However, compared to the control group, the

188 treatment group included more males, participants with children, and annual incomes between
189 $50,000 and $100,000.

190 A comparison of the sample to the general population of Delaware, where most of the
191 participants resided (72.8%), showed that our sample was broadly representative of the state's
192 population in terms of age, gender, and income. Our sample exceeded estimates for Delaware's
193 population in terms of employment rate, number of children in the household, and education level.

194 **Table 1. Summary statistics for socio-demographic variables by treatment.**

Variable	Definition	Entire Sample	Control	Treatment	Delaware (2018)[a]
Age	Participant's age in years in 2018	**40.70** (15.00)	**41.12** (15.35)	**40.28** (14.65)	**40.20** (Median)
Male	Equals 1 for male participants	**0.438** (0.496)	**0.494** (0.500)	**0.383** (0.487)	**0.484**
Children	Equals 1 when a child under 18 resided in the household	**0.416** (0.493)	**0.370** (0.483)	**0.461** (0.499)	**0.252**
Employed	Equals 1 when participant was employed	**0.659** (0.474)	**0.662** (0.473)	**0.656** (0.476)	**0.586**
$Income_{<\$50K}$	Equals 1 when participant's income was less than $50,000	**0.315** (0.465)	**0.344** (0.476)	**0.286** (0.452)	**0.383**
$Income_{\$50K-\$100K}$	Equals 1 when participant's income was between $50,000 and $100,000	**0.354** (0.478)	**0.299** (0.458)	**0.409** (0.492)	**0.322**
$Income_{>\$100K}$	Equals 1 when participant's income was greater than $100,000	**0.331** (0.471)	**0.357** (0.480)	**0.305** (0.461)	**0.296**
Education level	Equals 1 for participants who had a bachelor, graduate, or professional degree	**0.672** (0.470)	**0.682** (0.466)	**0.662** (0.473)	**0.314**
Urban	Equals 1 for participants living in urban areas	**0.873** (0.333)	**0.890** (0.314)	**0.857** (0.350)	
Homeowner	Equals 1 for participants who owned their homes	**0.679** (0.467)	**0.662** (0.473)	**0.695** (0.461)	
$Lawnsize_{small}$	Equals 1 when lawn size was less than 0.25 acres or participants did not have a lawn	**0.425** (0.495)	**0.422** (0.494)	**0.429** (0.495)	
$Lawnsize_{medium}$	Equals 1 when lawn size was between 0.25 and 1.0 acres	**0.448** (0.498)	**0.435** (0.496)	**0.461** (0.499)	

$Lawnsize_{large}$	Equals 1 when lawn size was greater than 1.0 acres	**0.127** (0.333)	**0.143** (0.350)	**0.110** (0.314)	
Lawn practice	Equals 1 when participants use environmentally friendly practices at home for the lawn	**0.844** (0.365)	**0.831** (0.375)	**0.857** (0.350)	
N		**308**	**154**	**154**	**949,495**

Mean values are in bold. Standard deviations are in parentheses.
Although t-tests showed that only male, children, and $income_{\$50K\text{-}\$100K}$ are not balanced between the control and treatment groups, joint orthogonality tests showed that none of the variables are jointly orthogonal to the treatment.
[a] Source: 2018 American Community Survey: www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2018/.

Analysis

The 308 participants in the experiment each made three 'Yes/No' purchase decisions, resulting in 924 observations. Given the binary nature of the decisions, we used a logistic regression to analyze the impact of the testimonial on purchases. Since any effect of the testimonial was constant for the three decisions, we used a random effects logistic model with the following specification [48]:

$$P(D=1) = \frac{\exp\left(\beta_0 + \beta_1 P + \beta_2 Testimonial + \boldsymbol{\gamma}'\mathbf{Z} + \varepsilon\right)}{1 + \exp\left(\beta_0 + \beta_1 P + \beta_2 Testimoninal + \boldsymbol{\gamma}'\mathbf{Z} + \varepsilon\right)} \quad (1)$$

where D is a dummy variable indicating purchase decisions, $D = 1$ represents a 'Yes' decision, and P is the posted price. *Testimonial* is a treatment dummy variable indicating whether a participant watched the video testimonial. Therefore, β_2 is the coefficient of interest that shows the treatment effect. $\mathbf{Z}$ is a vector of the socio-demographic variables presented in Table 1, and ε is the individual stochastic error term. We estimated two models: a simple model that did not include the socio-demographic variables and a more complex one that included all of the socio-

demographic variables to control for unbalanced variables between the control and treatment groups.

Using coefficient estimates from the logistic regression, we calculated the mean WTP for native plants following [49]:

$$WTP = \frac{1}{\widehat{\beta_1}}(\widehat{\beta_0} + \widehat{\beta_2} Testimonial + \widehat{\boldsymbol{\gamma}}'\bar{\boldsymbol{Z}}) \quad (2)$$

in which *Testimonial* = 1 for WTP by treatment participants and *Testimonial* = 0 for WTP by control group participants. $\bar{\mathbf{Z}}$ includes the mean values (e.g., age, income) of the socio-demographic variables for the control and treatment groups. The models were estimated using maximum likelihood, and mean values and standard errors of WTP were calculated using the delta method in Stata.

Results

We first examine participants' purchasing decisions by looking at differences in the percentage of participants who were willing to purchase native plants at each posted price (percentage of 'Yes' responses). As shown in Fig 3, the percentage of participants willing to purchase the native plants decreased as the posted price increased. Interestingly, only about 80% were willing to take the free native plants (price of $0). The fact that some participants did not want the plants likely reflected both their landscaping preferences and being unwilling to assume the cost and/or care of the plants. About 43.5% and 27.3% of participants were willing to purchase the plants at $3 and $6, respectively.

Fig 3. Percentage of 'yes' responses at each price.

As Fig 3 shows, the percentage of participants willing to take the free plants in the control and treatment groups is identical (79.2%). At a price of $3, more treatment participants (51.9%) than control participants (43.5%) were willing to purchase the native plants. At $6, slightly more control participants (27.3%) than treatment participants (25.3%) were willing to purchase the plants.

Table 2 reports the coefficients estimated from the random effects logistic regression used to identify factors that influenced participants' likelihood of purchasing native plants. We present the results for both the simple model that estimated only the treatment effect (Model 1) and the expanded model that included the full set of socio-demographic characteristics (Model 2). Based on the log pseudolikelihood, Model 2 slightly outperformed Model 1 so we draw our conclusions from the results from Model 2.

Table 2. Random effects logistic regression results.

	Model 1		**Model 2**	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**
Price	-0.655***	(0.067)	-0.656***	(0.067)
Testimonial	0.152	(0.305)	0.112	(0.307)
Age			-0.038***	(0.011)
Male			0.159	(0.305)
Children			-0.299	(0.314)
Employed			-0.232	(0.318)
$Income_{\$50K-\$100K}$			0.932**	(0.402)
$Income_{>\$100K}$			0.818*	(0.448)
Urban			-0.219	(0.548)
Education level			0.304	(0.332)
Homeowner			0.524	(0.362)
$Lawnsize_{medium}$			-0.099	(0.342)
$Lawnsize_{large}$			0.792	(0.504)

Lawn practice			0.761*	(0.402)
Constant	1.987***	(0.302)	2.076**	(0.807)
Log pseudolikelihood	-504.192		-491.869	
N	927		927	

***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

The results of the regression indicate that price had a negative effect on opting to purchase the plants. This result is expected and is evident in Fig 3. We also find that the coefficient of the variable of interest, *Testimonial*, is positive but not significantly different from zero. Thus, we find that the video testimonial had no significant effect on participants' decisions about purchasing native plants.

In terms of socio-demographic characteristics, we find that older participants were less likely to purchase native plants than younger participants and that higher income ($50,000 or more per year) participants were more likely to purchase native plants than were lower income (less than $50,000 per year) participants. We further find that participants who already used environmentally friendly practices to care for their lawns were more likely to purchase native plants. This result is intuitive since planting native species represents pro-environmental behavior.

Using equation 2 and the coefficient estimates from Model 2, we calculated the mean WTP for native plants for the control and treatment groups and report the results in Fig 4. The mean WTP for native plants by treatment participants was $0.26 higher than the mean WTP by control participants, which (consistent with the results of our earlier analysis) is not statistically significant. Thus, these results further indicate that the video testimonial did not have a significant impact on participants' WTP for native plants.

Fig 4. Mean willingness to pay for native plants. Note: Dots represent mean WTP estimates. Vertical lines represent 95% confidence intervals calculated using the delta method.

Collectively, our findings from the random effects logistic model and analysis of mean WTP values show that the behavioral intervention of providing participants with a video testimonial by an expert did not result in significant changes in participants' preferences for the pro-environmental behavior of buying native plants.

Failing to reject the null hypothesis of no treatment effect implies that either there is no treatment effect or the experiment did not have enough statistical power to detect the effect [50]. We conducted an ex-post power analysis to determine the size of the testimonial effect that we could detect with 80% power using our sample of 308 participants. The results of the power analysis vary depending on the underlying assumptions made about the distribution of WTP values. Our assumptions for the power analysis were guided by two previous studies of WTP for native plants. Using an experimental auction, Yue et al. [51] estimated the mean and standard deviation for plants labeled native/noninvasive as $2.79 and $2.90, respectively, with 5% of the bids at $0. Li et al. [15] estimated the mean and standard deviation to be $4.55 and $4.98, respectively, with 20% of the bids at $0. The results of these two studies suggest that the mean and standard deviation of values are similar in magnitude and that the distribution of values is skewed to the left. Considering the value distributions from these two studies, we conduct two ex-post power analyses. First, we calculate the minimum detectable effect size using Stata's 'power' command. Assuming a mean and standard deviation of $3.00, the minimum detectable effect size is $0.96, which equates to a standardized effect size of about 0.32. Since this calculation does not account for the structure of our data and the fact that we are not eliciting WTP values directly, we also use a simulation approach to calculate our power using the

experimental auction bids elicited in Li et al. [15]. From this analysis, we find that our study is designed to detect an effect of $1.50 with 80% power.

Based on our power analyses, we cannot rule out the possibility that the testimonial has an effect below the $0.96 to $1.50 range. A larger sample size would allow us to detect smaller effects at the cost of recruiting and paying more participants. Researchers must weigh these costs against the potential benefits of detecting smaller effects. For example, our ex-post power analysis using the same simulation showed that we would have needed a sample of 6,000 participants to detect a $0.26 difference in mean WTP. Thus, it is possible that the video testimonial induced differences in mean WTP that were smaller than our study was able to detect, but such differences would not necessarily be economically meaningful for policy and program designs aimed at promoting pro-environmental behavior.

Discussion

As policymakers, program managers, and practitioners seek new ways of integrating nudge-style behavioral interventions into policies and programs designed to promote pro-environmental behavior, a more robust literature is needed that not only identifies what does work, but importantly also identifies things that do not work or have limited impacts. This study examines the effectiveness of a testimonial (broadly defined as opinions and recommendations expressed by experts or influencers encouraging a behavior) by an environmental expert. Despite effective and widespread use of testimonials to market consumer goods and influence health-related decisions [17,20–27,29], little research has been conducted on using testimonials to encourage pro-environmental choices. We test this behavioral intervention in an incentive-compatible experiment involving actual consumer decisions about purchasing a native plant for their residential lawns as an environmentally beneficial landscaping choice. We compare the WTP for

native plants between participants who viewed a video testimonial from a renowned expert in the field about the benefits of native plants and participants who did not view the video testimonial.

Contrary to studies of testimonials used in other contexts [17,26,32], we find that the expert's video testimonial had no significant identifiable effect on WTP for native plants. Consequently, in pro-environmental contexts, testimonial-based interventions alone are not necessarily sufficient to motivate changes in behavior.

We further find that consumers who are younger, have relatively higher incomes, and already use other environmentally friendly practices for their lawns are more likely than other consumers to purchase native plants. These findings are consistent with previous studies exploring the determinants of pro-environmental behavior (see Blankenberg and Alhusen [52] for a review).

Our results make several important contributions. First, we extend the literature examining non-monetary nudges on adoption of pro-environmental behavior by analyzing the effect of expert testimonials using a carefully designed, revealed preference experiment. Publishing null results of sufficiently powered economic studies is critical to efforts to address publication bias that occurs when only statistically significant findings are reported [53]. Finally, our findings have practical implications, particularly for environmental organizations considering using expert testimonials to increase engagement in their programs. Our results show that such organizations should consider whether the cost of creating and disseminating testimonials is worth the expected benefit, which could be quite small based on the results of our study.

While our results make valuable contributions to the literature, we must acknowledge several limitations. We test the influence of a testimonial in a specific context – purchase of

native plants. Future research could determine whether testimonials can influence other types of pro-environmental behavior. Furthermore, future studies could test the effect of combining testimonials with other non-monetary behavioral interventions and/or financial incentives. Finally, studies conducted with larger samples could potentially detect smaller effects of testimonials alone.

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Supporting Information

S1 Appendix A. Transcript of the video testimonial provided by an expert.

S2 Appendix B. Experiment instructions and survey questions.