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Methodological and Ideological Options

The importance of selecting the right messenger: A framed field experiment on recycled water products

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ABSTRACT

This study tests how different messengers—scientists, government agencies, non-profit organizations, and newspapers—influence individual behavior. We conducted framed field experiments to compare the effects of these messengers on consumers' monetary bids on different items produced with recycled and conventional irrigation water. Using recycled wastewater for agricultural irrigation has the potential to conserve substantial amounts of fresh water. Although using recycled water for irrigating of both edible and inedible crops can be safe for human consumption, people may stigmatize these products since the origin of the waste water is still too apparent. Providing consumers with information about recycled water can help ameliorate their negative perceptions, and the effectiveness of such information can depend on the origin, i.e. the messenger. Our results suggest that participants respond least favourably when the message is attributed to a scientist and most favourably when the message is attributed to a newspaper. Further analysis shows that consumer responses to the scientist messenger fall into two general categories: (1) individuals who place zero bids and (2) individuals who place relatively larger bids in response to information from scientists.

1. Introduction

Effective communication depends, in part, on perceptions of the veracity and potential biases of its provider. Therefore, the individuals, organizations, and institutions that function to transmit information are an integral part of the decisions that consumers make. When individuals trust the "messenger," they are more likely to trust the information; when they do not trust the messenger, they might reject the information entirely (Haynes et al., 2007; Arbuckle et al., 2015). Thus, two messengers providing the same information can lead to quite different interpretations. This research specifically looks at the behavioral differences induced by different messengers. Moreover, using field experiments, we apply these potential behavioral interventions in a framework that addresses a timely and important natural resource issue – the use of recycled water[1] in agriculture. Previous research suggests that the use of recycled water may induce strong visceral responses among consumers (Savchenko et al. 2018; 2019; Kecinski and Messer, 2018). Our study tests if, and how, messengers impact individual behaviors related to the purchase of products (strawberries and T-Shirts) that have come into contact with recycled water.

A number of studies have examined the effect of public trust in various messengers on perceptions of environmental products. Most used surveys and hypothetical questions to investigate how individuals ranked trust for different types of messengers. The findings in existing literature differ, especially regarding the public trust for scientist messengers.

For instance, in a survey related to genetically modified foods in the United Kingdom, Hunt and Frewer (2001) found that the most trusted entities were university scientists (see also Haynes et al., 2007). Respondents were less likely to trust local news reports, government ministers, and tabloid newspapers. Arbuckle et al. (2015) compared trust in six environmentally-oriented interest groups and found that farmers in Iowa trusted scientists the most and mainstream media outlets the least. Dolnicar and Hurlimann (2010) used interviews and focus groups to examine influences on public acceptance of alternative water sources and asked participants about the organizations and individuals who most influenced their attitudes about water issues. The top three sources were research findings (88%), publicized news and

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[1] Ellis et al. (2019) showed that consumers disliked the name "recycled water," thus suggesting that different names for "recycled water" may potentially improve consumer acceptability.

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information (84%), and scientists (76%), followed by environmental groups and organizations (63%), the media (45%), and the government (38%).

However, more recently, several studies have found that the public's trust in scientist messengers is declining. Bubela et al. (2009) attributed the loss of trust to perceptions of scientific endeavours as increasingly interdisciplinary, bureaucratic, globally focused, and funded by private dollars (see also Higgins, 2016; Makri, 2017). In a study of genetically modified food, Huffman et al. (2004) used a survey approach and found that 36.1% of respondents rated the "other/media" category as the most trustworthy source of information, followed by third-party and scientific sources (29.6%), the government (19.5%), private industries (5.0%), and environmental and consumer groups (3.8%) while 6% viewed none of the messengers as trustworthy. Leiserowitz et al. (2012) identified a similar trend. They examined the impact of the 2009 "Climategate" scandal on the public's beliefs about global warming and trust in information provided by scientists. Between 2008 and 2010, the percentage of Americans who believed in climate change fell from 71% to 57% while the percentage of Americans who denied the existence of climate change rose from 10% to 20%. Although 74% of Americans trusted scientists' information about climate change and only 36% trusted information on climate change presented in the media, this study found that trust in scientists as a source for accurate information about global warming had dropped by approximately 9%.

Agricultural production depends heavily on having adequate water available, and a vast quantity of water is required for the U.S. agricultural industry. In 2016, agricultural uses accounted for 80% of the United States' total water consumption and for > 90% of the water consumed in many western states (USDA-ERS, 2016). As a consequence, traditional water sources such as reservoirs, rivers, and wells drawing from underground aquifers are increasingly suffering from the effects of climate change, such as droughts and overuse (Aeschbach-Hertig and Gleeson, 2012). Hence, the future availability of water and sustainability of its use will predominantly depend on how the agricultural industry and policymakers address water-conservation efforts. A potential worldwide solution is using non-traditional sources of irrigation water, such as recycled water from wastewater treatment plants.

In the U.S., widespread adoption of recycled water irrigation will, at least in part, depend on consumer acceptance of foods and other products irrigated with these technologies. Cusimano et al. (2015) reported that farmers may be reluctant to adopt recycled water due to negative public perceptions, and similar stigmas have been associated with other new food-production technologies such as genetic engineering and irradiation (Aschemann-Witzel et al., 2017; Messer et al., 2017).

Consumers' concerns likely stem primarily from the fact that recycled water has been in contact with substances such as sewage that are viewed as disgusting. Though the same is true to varying degrees for literally all water on the planet, the fact that recycled irrigation water has "recently" (close relation between toilet and tap) been in contact with fecal matter and other potentially disgusting substances can create strong visceral responses (Rozin, 2001; Rozin et al., 1986; Keisner et al., 2013; Hoffman et al., 2014; Kecinski et al., 2016a,b). In a recent study, Savchenko et al. (2018, 2019) compared consumers' responses to various products irrigated with conventional and recycled water and found that, for the most part, participants strongly preferred products irrigated with conventional water. In an earlier study, Po et al. (2005) found that communities that initially supported the concept of water reuse later rejected it in practice. Similarly, Hurlimann and Dolnicar (2010) examined the case of Toowoomba, Australia in which public opposition, politics, timing, and information manipulation led to the community voting against a referendum to implement a wastewater reuse project. They show that the public may have had concerns about bias and difficulty trusting information sources on both sides of the referendum. Furthermore, Po et al. (2005) also found that acceptance of reused water declined with the degree of personal contact people had with a product (see also Rock et al., 2012; Menegaki et al., 2007). On the other hand, research has also suggested that these negative perceptions of recycled water may be partially mitigated through additional consumer information (Bakopoulou et al., 2008). Hence, it is important to determine how best to provide information about recycled water as a safe and sustainable irrigation method (Bastian and Murray, 2012).

We are aware of no prior studies that have used non-hypothetical field experiments involving actual purchase decisions to evaluate the importance of different messengers in mitigating negative perceptions and nudging consumers to accept agricultural products associated with recycled water. Our field experiment provides insight into both behavioral responses and WTP for agricultural products when the same information about the benefits of recycled water is provided by different messengers. Specifically, this study addresses three key questions: (1) Does providing information on the benefits of sustainable growing techniques affect consumers' acceptance of their use? (2) What are the impacts of messenger communication on consumers' WTP? (3) How effective are different types of messengers (newspapers, scientists, government agencies, non-profit organizations) in increasing the acceptability of recycled water products?

We found that information affected consumers' acceptance of recycled water use in agricultural irrigation. Our results further indicate that individual behavior can be influenced by messenger communication, but the direction of this effect depends on the messenger. Particularly, we find that the scientist messenger reduces participants' willingness to bid on products irrigated with recycled water relative to other messengers. For the participants who did choose to place a bid, receiving information from the scientist messenger resulted in greater WTP for products associated with recycled water than when the information came from other messengers. This study contributes to our understanding of how effective different types of communication mediums are in efforts to foster sustainable consumer decisions, allowing policymakers to improve their communications and thereby increase acceptance of environmentally friendly practices by broader sections of the public.

2. Experimental design

The Becker-DeGroot-Marschak (BDM) (Becker et al., 1964) auction is commonly used in experiments to generate incentive-compatible, demand-revealing results (see Boyce et al., 1992; Irwin et al., 1998; Messer et al., 2010; Li et al., 2018), and Lusk et al. (2001) and Rousu et al. (2005) showed that the BDM is useful for eliciting values in field settings. This present study used a BDM auction design to elicit participants' WTP for two items, fresh strawberries and all-cotton T-Shirts, produced with conventional and recycled irrigation water by presenting participants with six opportunities to bid: (1) T-Shirts made from cotton produced with conventional water, (2) T-Shirts made from cotton irrigated with recycled water, (3) T-Shirts made from cotton with no specification of the source of irrigation water used, (4) strawberries irrigated with conventional water, (5) strawberries irrigated with recycled water, and (6) strawberries with no specification made of the type of irrigation water used.

Each participant received $15 that could be used to purchase products in the auction via private bids made on tablet computers provided to them. Each participant i was asked to indicate the highest amount (B) that they would pay for each product j (Eq. (1)). Once the bidding rounds were completed, the computer program randomly chose one round for implementation and a price (R) for the product in that round (a similar approach was used by Li et al., 2018). The outcome of the auction was determined by:

$$Randomly\ Selected\ Product\ ij = \begin{cases} Purchase\ if\ B_{ij} \geq R_{ij} \\ No\ Purchase\ if\ B_{ij} < R_{ij} \end{cases} \quad (1)$$

where B_{ij} and R_{ij} were censored from below at $0 and from above at $15.

Participants' dominant strategy is to reveal their true WTP for each item since any deviation would result in a sub-optimal outcome. Participants who bid less than their true WTP would forego the opportunity to gain utility from purchasing the product, and participants who bid more than their true WTP would be forced to pay more than its value to them.

While BDM auctions are demand-revealing in theory, Lusk and Shogren (2007) have noted the importance of first providing participants with training and practice using the mechanism. Without it, participants can approach bidding heuristically, choosing to buy low or sell high and thereby thwarting the auction's ability to reveal their true demand. Plott and Zeiler (2005), on the other hand, showed that providing thorough training and explanations largely overcame misconceptions about bidding and offering behavior in such auctions.[2] In our experiment, we provided five rounds of "comprehension checks" before the participants placed their bids. Each of these rounds presented a question in the following format:

If your bid is $6 and the randomly drawn number is $10, what is the outcome?

(A) You purchase the product for $10 and have $5 remaining.

(B) You will not purchase the product and have $15 remaining.

After each practice question, the Python-based computer program indicated whether the participant had answered correctly, providing an opportunity for participants to learn from their mistakes.

To evaluate differences in how information from different types of messengers was perceived, the participants were randomly assigned to one of five groups—a no-information control group and four messenger treatment groups (see Appendix A for more details): (a) newspapers, (b) government agencies, (c) scientists, and (d) non-profit organizations. In the newspaper treatment, for example, the messenger provided information and an associated link on the benefits of using recycled irrigation water:

"*A newspaper article < LINK > has pointed to the positive impacts of using recycled water in agricultural production.*"

Participants who wanted more information could click on the link provided to view an excerpt of the article. The remainder of the statement and the wording in the excerpt in the treatments were identical; only the source of the information varied. This specification allowed us to observe how many participants chose to click the link and could potentially shed light on how the participants' behavior varied in terms of bidding. Note, these experiments did not use deception – the websites and links to the original sources (the messengers), all communicating the same message are in Appendix A.

For this study, participants were recruited at a branch of the Department of Motor Vehicles, a local ice cream parlor, and a Life-long Learning Center in the U.S. Mid-Atlantic region. Sampling in these diverse locations allowed us to collect data from a large cross-section of the population. At each location, the products in the auction were displayed on a table that was clearly visible to visitors and patrons. A second table near the entrance of the establishment provided the tablet computers loaded with the experiment. The sample was selected by approaching individuals at the establishment and inviting them to participate in a research study concerning water and a number of products that had been irrigated with the water. Individuals were also free to approach members of the research team, who were clearly visible at each location and welcomed individuals' participation. After signing the informed consent and reading the instructions (which included several detailed examples of the auction process), participants completed the comprehension checks involving five multiple-choice questions designed to familiarize them with the BDM mechanism (the instructions are provided in Appendix B). Then, prior to the auction, each participant was given the following definitions for conventional and recycled water:

Recycled Water: "*Recycled water is highly treated wastewater from various sources, such as domestic sewage, industrial wastewater, and storm water runoff.*"

Conventional Water: "*Typical sources of conventional water include: surface water, groundwater from wells, rainwater, impounded water (ponds, reservoirs, and lakes), open canals, rivers, streams, and irrigation ditches.*"

The auction involved three bids on strawberries and three bids on T-Shirts—one for each water condition (conventional, recycled, and no information)—that were presented in random order.

The instructions informed participants that they would receive $15 for their participation in the experiment and could keep the money or use it to purchase products in the auction. Bids in the auction were restricted from $0 to a maximum of $15. Once the bidding was complete, the participants also completed a brief survey that collected demographic information (Appendix C). Finally, the computer program randomly selected one of the rounds for implementation and established the product's price, thus determining the product purchased and the participants' net earnings.

3. Results

3.1. Descriptive and non-parametric results

Table 1 presents a summary of the demographic characteristics of the 201[3] individuals represented in the sample.[4] More than half, 60%, were female. The average age of the participants was 44 years old; the oldest was 92 and the youngest was 18. In terms of political affiliation, 39 respondents described themselves as conservative, 60 as liberal, and 79 as moderate; 18 stated that they were affiliated with a political group not listed in the survey.

Additionally, participants were asked in the survey how much they trusted information from all the sources used as treatments (scientists, government agencies, non-profit organizations, and newspapers). 44% of participants stated that they strongly agreed with trusting information from scientists. In the other categories, only 18% strongly agreed with trusting information from non-profit organizations, 7% strongly agreed with trusting newspapers, and 6% strongly agreed with trusting government agencies. The mean responses (measured on a 1–5 scale, where 1 means strongly disagree and 5 means strongly agree) for the treatments were as follows: scientists (4.06), government agencies (2.70), non-profit organizations (3.48), newspapers (3.01).

A Shapiro-Wilk test identified that participants' bids were not normally distributed ($p = 0.01$) (see appendix D for histograms of bids). Therefore, to compare individual bids made for products based on the water information provided, we use a non-parametric Wilcoxon match-pair signed-rank test. The results of this test indicated that there were no statistically significant differences between bids on the products under no-information, conventional water, and recycled water. While the Wilcoxon tests suggests no overall significant difference between

[2] Horowitz (2006) pointed to potential issues arising from the circumstances used in the auction. For instance, participants' valuations can be influenced by how they are asked to pay for the items.

[3] See Appendix F for an ex-post two means power and sample size analysis.

[4] Although participants were randomly assigned to treatment groups, we checked for balance of demographic characteristics across treatments. Based on results from ANOVA tests, we conclude that there is a balance of gender across the treatments as we fail to reject the null hypothesis of equal means for each treatment (p-value > 0.10). However, we find that there are significant differences across treatments for both age (p-value < 0.01) and political affiliation (p-value < 0.01). Note, due to the nature of these experiments (framed field experiments), it would have been difficult or impossible to ensure perfect balance across treatments.

Table 1
Summary of respondents' demographics and treatment balance information.

Summary	Categories	Overall	Treatments				
		Number (%)	Newspaper	Scientists	Government agencies	Non-profit organizations	Control
Gender (N = 197)	Female	118 (60%)	26 (57%)	24 (62%)	22 (55%)	25 (63%)	21 (66%)
	Male	79 (40%)	20 (43%)	15 (38%)	18 (45%)	15 (38%)	11 (34%)
	Other	0 (0%)					
Age (N = 195)	Mean	44	41.21	46.67	42.375	42.81	45.84
	Minimum	18	18	19	19	20	18
	Maximum	92	77	92	74	74	86
Political affiliation (N = 196)	Conservative	39 (20%)	8 (17%)	7 (18%)	12 (30%)	7 (18%)	5 (16%)
	Liberal	60 (31%)	15 (33%)	15 (38%)	10 (25%)	12 (30%)	8 (26%)
	Moderate	79 (40%)	21 (46%)	13 (33%)	14 (35%)	15 (38%)	16 (52%)
	Other	18 (9%)	2 (4%)	4 (10%)	4 (10%)	6 (15%)	2 (6%)

Note: The total number of participants was 201, however, due to missing survey responses, the number of observations was slightly lower for the above categories.

Table 2
Comparing bidding behavior by treatments using Mann-Whitney *U* tests.

Type	Scientists	Government agencies	Non-profit organizations	Control
Newspapers	3.817***	0.934	0.729	3.407***
Scientists		−2.788**	−2.992**	−0.546
Government agencies			−0.769	2.425*
Non-profit organizations				2.782**

Notes: Reported coefficients are based on z-statistic; a Bonferroni correction was applied to adjust for potential type I errors, where the new alpha level was set to account for the ten pairwise comparisons, $\alpha = 0.05/10 = 0.005$. Hence, the significance levels reported in this table reflect these adjustments, where ***, **, * signify statistical significance at ($p \leq 0.001$, $p \leq 0.005$, and $p \leq 0.01$ two-tailed, respectively).

the bids for products produced with recycled water versus conventional water, it is important to consider that in every treatment, excluding the control group, we provided positive information about recycled water. This may have countered a potential disgust response. See for example Bakopoulou et al. (2008), who found that providing information about the process of recycling water increased WTP for products irrigated with recycled water.

We then analyzed bidding behavior between the different treatment groups using a Mann-Whitney *U* test (Table 2). The results provided a first insight into the importance of the messenger on bidding behavior, which will be further analyzed using regression analysis below. We found statistically significant differences ($p \leq 0.01$, two-tailed) between all treatment groups and the control, except for the scientist messenger, indicating that newspaper, government agency, and non-profit organization messengers produce significantly larger median bids, but not the scientist messenger. We further found that comparing the scientist messenger to government agencies and non-profit organizations resulted in significantly ($p \leq 0.005$, two-tailed) smaller median bids. These results may seem counterintuitive in light of the above reported stated preferences concerning the amount of trust participants had in scientists. Nonetheless, it is precisely for this reason we believe our experiments are important – the stated and revealed preferences do not necessarily align and our data may provide such evidence.[5] No significant differences were found between the non-profit organizations messenger and both the newspaper and government agencies messenger. To gain further insight into these behaviors we used regression analysis.

Also note that only three participants[6] across all treatment groups chose to click the provided link to receive further information about the benefits of using recycled water. This is an interesting finding as it contributes to our understanding of how consumers' purchasing decisions are impacted by accompanied information. Specifically, it appears that participants' efforts to acquire further information were relatively small. The literature suggests that consumers are in favour of receiving more information about the production process, which is often presented in the form of product labelling (Bernués et al., 2003; Borin et al., 2011; Grunert and Wills, 2007; Hobbs and Kerr, 2006; Hu et al., 2005; Messer et al., 2015). Since most consumers are distanced from production processes now, they may have become increasingly concerned about the ethical, social, and environmental impacts of both food and clothing production. However, due to the small number of participants who chose to click the link in our study, we find that consumers are often not willing to spend time and effort to gain additional information beyond what is conveniently provided. Also, in the survey following the BDM auction, most respondents (65%) said they do not educate themselves about how their clothing was produced. Given the low number of participants that had clicked the link, we do not include this variable in the regression models below.

3.2. Regression results

We used regression models to explore participants' decision-making regarding the products with a specific interest in the effects of the messenger treatments and certain demographic characteristics. The experimental data revealed a large number of $0 bids (see also Appendix D). There are also clusters of bids around $5 for T-Shirts and $3.50 for strawberries. These observations may represent the participants' perceived market prices for those products. Colson et al. (2010), for example, collected data on individual perceptions of market prices in a WTP experiment and used those prices as upper censors in their model (see also Harrison et al., 2004). However, they collected the data in a grocery store so the consumers' transaction cost to purchase goods outside of the auction was extremely low; upper censoring at the perceived market price was a realistic specification of that model. Our experiment did not collect data on the participants' perceptions of market prices. Additionally, the transaction cost of purchasing the strawberries and T-Shirts elsewhere was higher in terms of both dollars and availability of products labeled with the type of irrigation water

[5] Additionally, one might also consider the possibility that the stated and revealed preferences results are not contradictory at all. In fact, one might truly have high levels of trust in scientists while at the same time one may not want to think "scientifically" about water or food production; in other words, there may be a general level of trust in scientists but people may not want the science when it comes to certain aspects of decision making, for example genetically engineered foods and ingredients, among other things.

[6] All three participants were part of the newspapers treatment. However, there are too few observations to draw inference from this finding.

used; therefore, we do not use upper censoring in our analysis.

We used three models to explain and interpret the data. The first model employs a hurdle specification (with a lower limit at zero). In this hurdle model, we analyze the effects of the messenger treatments on WTP using all of the products. In the second analysis, we explore the effects of demographic variables on stated trust in scientific messengers using an ordered probit model. Then we apply a difference-in-difference model to examine the effects of the messenger treatments and demographic characteristics on differences in bids for items produced with recycled versus conventional water.

A hurdle model is appropriate to analyze the effects of the messenger treatments on WTP because it accounts for the large number of $0 bids. In this model, we include indicator functions for between-subject messenger treatments in both the selection and outcome (Cragg, 1971; Greene, 2012). The selection portion of the model captures individual decisions about whether they are interested in bidding on the product. The variable y^* represents an unobservable comparison of marginal costs and marginal benefits in terms of utility that the consumer theoretically makes and y is the observable bid placed. The variable z represents the decision of the respondent to place a bid ($z_{ij} = 1$) or not ($z_{ij} = 0$). If the marginal benefits of placing a bid are greater than the marginal costs (Eq. (2)), then the respondent will place a bid. The outcome portion analyzes how the independent variables affect the nonzero bids. The dependent variable in this outcome model is the values of the bids submitted by all respondents for all of the products. The key independent variables, x', are the dummy variables for each between-subject treatment messenger (newspapers, scientists, government agencies, and non-profit organizations), which were compared to the no-information control group and γ is the vector of coefficients for these unobservable attributes. In this model, Φ represents the standard normal cumulative density function, σ is the standard deviation, and λ represents the inverse Mills ratio, which is a weighting method for the error term, $\sigma\lambda$ (Greene, 2012). Since we do not require a weighted error for our purposes (as participants were randomly assigned to treatments), we assume $\sigma\lambda_{ij} = \epsilon_{ij} \sim N(0, \sigma^2)$. The models are indexed by individual i and product j (see Greene, 2012).

$$Prob[y_{ij}^* > 0] = \Phi(x_{ij}'\gamma),\ z_{ij} = 1\ if\ y_{ij}^* > 0 \tag{2}$$

$$Prob[y_{ij}^* \leq 0] = 1 - \Phi(x_{ij}'\gamma),\ z_{ij} = 0\ if\ y_{ij}^* \leq 0 \tag{3}$$

$$E[y_{ij} \mid z_{ij} = 1] = x_{ij}'\beta + \sigma\lambda_{ij} \tag{4}$$

Eqs. (2) and (3) are the participation equations that estimate the selection portion of the hurdle model – whether a respondent chose to participate in the auction by placing a positive bid (a binary choice model). Eq. (4) is the intensity equation and estimates the outcome portion of the hurdle model – how much participants were willing to bid after crossing the zero-bid hurdle (censored at the upper-limit of 15, continuous model). The hurdle model was further separated into a treatments-only model (M1) and a treatments-plus demographics model (M2).

The results of both M1 and M2 of the hurdle model indicate that the nature of the messenger has a significant effect on participants' behavior for all products, as shown in Table 3.[7] However, the coefficients for the scientist messenger treatment show stark differences between choosing whether to bid zero and the amount of the bid. The scientist messenger coefficient in the selection model is negative and significant; participants who received that treatment were significantly less likely to place a bid on a product. In the outcome model, the reverse was true. On average, participants who cross the zero-hurdle submitted a bid that was significantly higher than the participants in the no-information control treatment. Participants under the other three messenger treatments were more likely to place a positive bid and bid higher amounts than participants under the control treatment. While all treatments resulted in greater WTP compared to the control in the outcome model, the newspaper treatment coefficient had the largest magnitude.[8] In M2

Table 3
Results from the hurdle model examining the effects of messenger treatments on participants' willingness to pay compared to the no information control treatment (with, M2, and without, M1, demographic variables).

Bid	M1: coefficient (Std. Err.)	p-Value	M2: coefficient (Std. Err.)	p-Value
Selection model				
Newspaper	0.285* (0.165)	0.084	0.428*** (0.172)	0.013
Science	−0.496*** (0.147)	0.001	−0.457*** (0.153)	0.003
Government	0.145 (0.165)	0.380	0.215 (0.172)	0.210
Non-profit	0.368** (0.177)	0.038	0.402** (0.185)	0.030
Control		(Omitted)		
Age			0.002 (0.003)	0.589
Female			0.142 (0.106)	0.182
Liberal			(Omitted)	
Moderate			0.248 (0.121)	0.041**
Conservative			0.251 (0.144)	0.082*
Other			0.968 (0.280)	0.001***
Constant	1.238*** (0.117)	0.000	0.820 (0.210)	0.000***
Outcome model				
Newspaper	1.203*** (0.394)	0.002	1.307*** (0.397)	0.001
Science	0.939** (0.426)	0.028	1.061*** (0.428)	0.013
Government	0.847** (0.411)	0.039	0.912** (0.413)	0.027
Non-profit	0.784* (0.409)	0.055	0.951** (0.412)	0.021
Control		(Omitted)		
Age			−0.026*** (0.007)	0.000
Female			−0.714*** (0.245)	0.004
Liberal			(Omitted)	
Moderate			−0.010 (0.293)	0.973
Conservative			0.178 (0.347)	0.608
Other			0.654 (0.437)	0.135
Constant	3.220*** (0.334)	0.000	4.619*** (0.535)	0.000

Notes: N = 1206; Prob > Chi^2 = 0.0000; *, **, *** denote significance at a 10%, 5%, and 1% level, respectively. A list of control and coefficients can be found in Appendix E.

[7] A hurdle model was also run with only products produced with recycled water and produced similar results in terms of significance and direction of coefficient effects; however, there was reduced overall significance of the model due to a reduction in the number of observations.

[8] A Wald joint hypothesis test is used to test the overall significance of the model, which tests the treatment coefficients in both the selection and outcome models in M1. From this test, we reject the null hypothesis of no differences between the treatments (p-value = 0.0471 for the outcome model and p-value = 0.0000 for the selection model). This is relevant because it is important to understand what information is driving the behavior of respondents. In this study if the message, the positive information statement, was the major influence on participant behavior, we would expect the messenger treatments to all

of the hurdle model, we further found that demographic characteristic had significant impacts. In the selection part of the model, political affiliation mattered insofar as moderate, conservative, and other political views have a positive impact on placing a bid compared to liberal participants. In the outcome model, political affiliation did not significantly impact decision-making. However, here we found that both being female and being older had a negative impact on the amount of money participants were willing to pay for the products.

Since we observed that the scientist messenger treatment produced results that partially deviate from participants' stated trust in scientists from the survey results,[9] we further explored demographic effects on stated trust. Stated trust, the dependent variable in this second analysis (y_i), is ranked from strongly disagree (1) to strongly agree (5), so we used an ordered probit model to account for the ordinal values; age, gender, and political affiliation are included as explanatory variables (x_i') (Eqs. (5) and (6)). In these equations, y_i^* is the latent variable, μ represents the choice alternatives, and γ is an unknown parameter estimated with β (Greene, 2012).

$$y_i^* = x_i'\beta + \varepsilon_i \tag{5}$$

$$y_i = \mu \text{ if } \gamma_{\mu-1} < y_i^* \leq \gamma_\mu \tag{6}$$

From this model, we conclude that as age increases, the latent variable of trust in scientific sources decreases, but there is no gender effect present (Table 4). We also found that the probability of participants selecting strongly disagree to trusting information from scientific sources (1) increased when a respondent states conservative, moderate, or other political affiliation compared to liberal affiliation. Therefore, it appears that the stated preferences of trusting scientists may be impacted by political affiliation and age.

The third model we considered was a modified difference-in-difference model. This model analyzes the difference between bids for recycled and conventional irrigation methods and how such difference varies between control and treatment groups. In this model, the dependent variable, w_{ik}, is the difference between bids for a product produced with recycled water (Bid_r) versus the same product produced with conventional water (Bid_c) (Eq. (7)).[10] The independent variables in this case were the treatment dummies as well as the age, gender, and political affiliation of the respondents (Eq. (8)). This model also includes a dummy variable to indicate whether the item was a T-Shirt or strawberry, which is denoted as k in Eqs. (7) and (8), and i is the individual.

$$w_{ik} = (Bid_r - Bid_c)_{ik} \tag{7}$$

$$w_{ik} = x_{ik}'\beta + \varepsilon_{ik} \tag{8}$$

where $\varepsilon_{ik} \sim N(0, \sigma^2)$.

Since bids were censored from below at \$0 and above at \$15, the value of w_{ik} only equals the true difference, w_{ik}^* when participants' true bids for the recycled and conventionally irrigated products fall within the set (0, 15) (Eq. (9); Li et al., 2017). The full relationship of the latent variable, w_{ik}^* is:

Table 4
Results from the ordered probit model examining the effects of demographic variables on participants' stated trust in information received from scientific sources ranked from strongly disagree (1) to strongly agree (5).

Trust in science	Coefficient	Standard error	p-Value
Ordered probit			
Age	−0.0084***	0.0018	0.000
Female	0.0366	0.0673	0.586
Political affiliation			
Conservative	−0.5860***	0.0940	0.000
Moderate	−0.3911***	0.0814	0.000
Other	−1.2234***	0.1249	0.000
Liberal		(omitted)	
Cut 1	−2.7129	0.1381	–
Cut 2	−2.2400	0.1272	–
Cut 3	−1.3695	0.1184	–
Cut 4	−0.5608	0.1146	–

Notes: N = 1164; Prob > Chi2 = 0.0000; *, **, *** denote significance at a 10%, 5%, and 1% level, respectively.

$$w_{ik}^* = \begin{cases} w_{ik} = \alpha_i + X\beta + \varepsilon_{ik} & \text{If } 0 < Bid_c < 15 \text{ and } 0 < Bid_r < 15 \\ [Bid_r, \infty) & \text{If } Bid_c = 0 \\ (-\infty, -Bid_c] & \text{If } Bid_r = 0 \\ (-\infty, Bid_r - 15] & \text{If } Bid_c = 15 \\ [15 - Bid_c, \infty) & \text{If } Bid_r = 15 \\ (-\infty, \infty) & \text{If } Bid_c = 0 \text{ and } Bid_r = 0 \\ (-\infty, \infty) & \text{If } Bid_c = 15 \text{ and } Bid_r = 15 \\ (-\infty, -15] & \text{If } Bid_c = 15 \text{ and } Bid_r = 0 \\ [15, \infty) & \text{If } Bid_c = 0 \text{ and } Bid_r = 15 \end{cases} \tag{9}$$

However, it is unlikely that the upper bid was highly limiting for respondents' bids; the range for bidding (\$0 to \$15) was large enough to capture most of the variation in these bids. There were 9 bids out of 1206 at the upper limit of \$15. Bids of \$0, on the other hand, likely reflect participants' rejection of the products. The restrictions described in Eq. (9), particularly those that tend to negative infinity, though theoretically possible, seem rather unlikely, as a large negative WTP would indicate that participants would reject small amounts of money to accept goods they could immediately discard or give to others. Therefore, we acknowledge the mathematical possibility that differences in bids, w_{ik}, do not necessarily equal the true value of the difference, w_{ik}^* – but these discrepancies should be negligible.

The results from the difference-in-difference analysis are reported in Table 5. They show that, in general, positive information about recycled irrigation water from any type of messenger resulted in higher relative WTP[11] for the recycled-water items. This result is perhaps intuitive since consumers are likely to have some positive responses to such information. Only the newspaper-messenger treatment had a statistically marginally significant effect with a magnitude of \$0.65. However, since the average bid in the experiment is \$4.23, it represents a rather large effect (15.6%) on individuals' WTP for the recycled-water product. We found no significant effects for gender and age. There was a statistically significant increase in relative WTP (at the 1% level) when the product was a T-Shirt. A potential explanation for this finding may be that it demonstrates the difference in consumers' responses to products they consume (oral contact) versus products they wear (skin contact); that is, they were significantly less concerned if the product was a T-Shirt compared to when the product was strawberries. The

(*footnote continued*)
have the same effect on willingness to bid and WTP since the message displayed was the same for each participant. Since there are differences in the coefficients of the hurdle model, this suggests that the messenger influences participant behavior.

[9] Recall, participants stated that they trusted scientist more than newspapers, government, and non-profit organizations. However, their behavior in the revealed preference section of these experiments is not consistent with this – the selection model of the hurdle specification showed that, in fact, they were significantly less likely to place bids compared to the other treatments.

[10] We are most interested in analyzing what drives the difference between WTP for products irrigated with recycled and conventional water because when a water source is identified as recycled by media, it implicitly suggests that the competing products used non-recycled (aka. conventional) water.

[11] Note that relative WTP is the difference in WTP for recycled water T-Shirts and conventional water T-Shirts versus recycled water strawberries and conventional water strawberries – it is this relative difference between the two products that the regression analysis accounts for. So, the 'Shirt Products' products variable indicates that the difference between recycled and conventional water is significantly smaller than the difference between recycled and conventional water for strawberries.

Table 5
Results from difference-in-difference model examining the effects of participants' relative willingness to pay for products produced with recycled water compared to conventional water.

Bid	Coefficient	Standard Error	p-Value
Difference-in-difference model			
Newspapers	0.6453*	0.3834	0.092
Scientists	0.3528	0.3975	0.375
Government agencies	0.3262	0.3969	0.411
Non-profit organizations	0.1806	0.3993	0.651
Gender	0.1131	0.2453	0.645
Age	0.0047	0.0065	0.467
Shirt products	0.4329***	0.1686	0.010
Political affiliation			
Conservative	−1.2544***	0.3422	0.000
Moderate	−0.5358*	0.2882	0.063
Other	−0.7459	0.4610	0.106
Liberal		(Omitted)	
Constant	−0.4245	0.5145	0.409

Notes: N = 388; Wald Chi^2 = 25.30; Prob > Chi^2 = 0.0048; *, **, *** denote significance at a 10%, 5%, and 1% level, respectively.

regression model also shows that the politically conservative and moderate participants' WTP for recycled-water products was lower than the WTP of politically liberal participants on average. The differences are significant at the 1% (conservative) and 6% (moderate) level.

4. Conclusion and discussion

The agricultural industry is the single largest consumer of fresh water in the United States and in many other countries around the world. Therefore, agriculture plays a vital role in promoting sustainable water usage. Water recycling may be a sustainable and cost-effective way to irrigate crops safely and could increasingly be needed. But producers have been reluctant to adopt the technology because of the risk of rejection of the products by consumers due to stigma associated with what was once wastewater. Prior studies have shown that many consumers have developed strong negative perceptions about new food-production technologies such as irradiation and genetic modification (Messer et al., 2017). A similar process could affect their WTP for products irrigated with recycled water and thus could hinder farmers' adoption of the technology.

Evidence in the related literature shows that positive information about a potentially stigmatizing technology can increase public acceptance of it (see, for example, Liaukonyte et al., 2013). Furthermore, some recent research has explored individuals' degrees of trust in information provided by different messengers using a survey approach. Several of the studies (i.e. Hunt and Frewer, 2001; Arbuckle et al., 2015) found that participants trusted scientific sources the most, but others (Bubela et al., 2009; Leiserowitz et al., 2012) found that participants' trust in scientist messengers was declining.

This study is the first to use non-hypothetical experiments to examine consumers' preferences for an environmentally friendly practice and the effect of different types of messengers providing positive information about the practice. We analyze consumer preferences in the context of items produced using recycled wastewater for irrigation. We conclude from our results that the provided information affected consumers' acceptance of the use of recycled water in agricultural irrigation. Specifically, messengers can significantly impact consumer behavior. However, how specifically messengers impact behavior will depend on the type of messenger and the type of decision an individual makes. We found that a messenger carrying information from scientists can lead to conflicting outcomes. Our results show that participants under the scientist messenger treatment were generally less likely to place a positive bid when compared to the control. People in the scientist messenger treatment also placed relatively higher bids if they chose to bid positive amounts. The newspaper treatment had the greatest impact in terms of increasing WTP of all the treatments – a recent poll also found a similar increase of Americans' confidence in newspaper sources (Newport, 2017). The poll asked Americans how much confidence they had across 14 institutions and the percentage of people who responded a 'great deal' and 'quite a lot' of confidence in newspapers increased from 20% in 2016 to 27% in 2017.

Our results may also dovetail with findings from previous studies (for example, Po et al., 2005) who showed that the degree of contact with recycled water is an important factor in the acceptance of the process – participants were more accepting of recycled water used to produce T-Shirts and less accepting of recycled water used for food production – perhaps suggesting that potential disgust related to oral ingestion reigns higher than the one associated with skin contact. We also conclude that political affiliation affects WTP since there was a negative effect of conservative and moderate political affiliation compared to liberal affiliation on the difference in bids between recycled and conventional irrigation water products.

Looking forward, including a question about participants' initial beliefs on the use of recycled water may augment future research. Documenting initial beliefs may help to better reform our understanding of what drives consumers' decisions and behaviors by establishing a frame of reference. In the future, it may also be interesting to study how negative information is perceived when compared to positive information, and how it influences consumers' decision-making. This could further explain the relationship of trust in information communication and purchasing decisions.

There is a push in the United States government, and governments around the world, for more evidence-based policy. The goal of evidence-based policy is to maximize the likelihood of successful policy implementation by using research to predict policy outcomes driven by real life decision-making (Government of Canada, 2017; Howlett, 2009). The results of this study can be used to inform public policy. This research provides evidence on how to improve the effectiveness of government communication; it shows that the interpretation of information is affected by the sources cited. In order to improve the acceptance of sustainable and cost-effective policies and technologies and ultimately lead to successful implementation of these programs, governments should consider the importance of not just the message being delivered, but also the associated messengers. Lastly, these results add to a growing body of evidence that there may be an overall decline in trust in scientists in the United States. We find that the decline may be explained by distinctly different behaviors. Some people have perhaps chosen to "turn their heads" from scientists and thus place zero bids altogether, while those who have chosen to place positive bids view scientific information as important and their behavior is influenced by it – these are important considerations for future studies and policies.

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Appendix A–F. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2019.03.004.

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