Measuring the Impacts of Different Messengers on Consumer Preferences for Products Irrigated with Recycled Water: A Field Experiment

by

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Abstract

This study tests how different messengers—scientists, government agencies, non-profit organizations, and newspapers—influence consumer behaviour. 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 it has been shown that using recycled water for irrigating for both edible and inedible crops can be safe for human consumption, people may stigmatize these products since the origin of the wastewater is too apparent. Providing consumers with information about recycled water can help ameliorate their negative perceptions, and the effectiveness of such information depends on who is the messenger. Our results suggest that participants respond least favourably to the scientist messenger and most favourably to the newspaper messenger. Further analysis shows that consumer responses to the scientist messenger fall into two general categories: (1) individuals who refused to place bids and (2) individuals who did place relatively larger bids in response to information from scientists.

Preface

This thesis is an original work by Alix Schmidt. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project name "Willingness to pay for agricultural products grown with non-traditional irrigation water", No. Pro00071733, April 25, 2017 and the University of Delaware Institutional Review Board, Project name "Perceptions of alternative irrigation waters", No. 874969-6, April 24, 2017.

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Chapter 1 Introduction

Effective communication depends, in part, on perceptions of the veracity and potential bias of its provider. Therefore, the individuals, organizations, and institutions that function to transmit information are an integral part of the decisions 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. Thus, two messengers providing the same information can lead to quite different interpretations.

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 their degree of trust for different types of messengers. These studies will be discussed in more detail in the Literature Review section. This present research, however, specifically looks at the behavioural differences induced by different messengers. Moreover, using field experiments, we apply these potential behavioural interventions in a framework that addressed a timely and important natural resource issue – the use of recycled water in agriculture.

Freshwater reserves only account for 2.5% of the total water on Earth (Figure 1; US Geological Survey 2016). Of this small percentage, approximately 70% of freshwater is locked in glaciers and ice caps which means there is limited freshwater sources available for human use and consumption, in the forms of groundwater, rivers, and lakes (US Geological Survey 2016). It is expected that water risks will continue to increase globally because of increased groundwater extraction and increased demand for water (OECD 2017). Climate change is also predicted to restrict freshwater availability due to increased extreme flooding events, increased precipitation variability, rising sea levels, and water quality deterioration (OECD 2017). An important water issue the world is facing is the failure to meet basic needs for water (Gleick 2003). Worldwide, over 1 billion people lack access to safe drinking water and 40% of the global population is affected by water scarcity (United Nations, Department of Public Information n.d.). The United Nations emphasized the importance of this issue by including the need to "ensure access to water and sanitation for all" in the Sustainable Development Goals (United Nations, Department of Public Information n.d.). While there is growing awareness of water issues, Gleick (2003) states that international economic support for projects providing water for human use is declining.

Total Global Water	
Oceans	96.5%
Freshwater	2.5%
Other Saline Water	0.9%

Freshwater →

Freshwater	
Glaciers and Ice Caps	68.7%
Groundwater	30.1%
Surface/ Other Freshwater	1.2%

Surface/ Other Freshwater →

Surface Water and Other Freshwater	
Ground Ice and Permafrost	69.0%
Lakes	20.9%
Soil Moisture	3.8%
Atmosphere	3.0%
Swamps, Marshes	2.6%
Rivers	0.5%
Living Things	0.3%

Figure 1: Freshwater reserves are limited. Of all global water reserves, oceans account for 96.5% while only 2.5% represents freshwater sources. 68.7% of the 2.5% of freshwater is unavailable for human consumption as it is stored in glaciers and ice caps. Lakes account for 20.9% of surface water and other freshwater, while rivers only account for 0.5% of this reserve. Note: The totals of these figures may not be 100% because of rounding.

Along with the distributional issues and declining economic support for water issues, freshwater reserves are declining. Freshwater reserves are declining globally due to demand increases from a growing population and increased climate variability (USDA-ERS 2016). According to the United

Nations (United Nations n.d.), over the last century water use has grown at more than twice the rate of population increase. Many problems arise due to the decline in freshwater supplies, including environmental, economic, and social consequences. There is environmental damage to freshwater ecosystems and freshwater fauna around the globe are in danger, which can be shown, for example, in North America where 27% of freshwater fauna are considered threatened with extinction (Gleick 2003; Ricciardi and Rasmussen 1999). Decreased river flows have also led to issues such as nutrient depletion, loss of habitat, declining bird populations, shoreline erosion, and negative effects on local communities (Cohen and Henges- Jeck 2001; Nixon 2003; Vorosmarty and Meybeck 2003). There are also economic implications when freshwater sources are fully or over-allocated within a management area; the South Saskatchewan River Basin (SSRB) in Alberta demonstrates an example of over-allocation of surface water (Alberta Environment 2006). As part of a newly created Water Management Plan for the SSRB, no new surface water permits are being granted for three sub-basins within the management area (Government of Alberta 2014). Therefore, the only way to obtain water permits in these closed sub-basins is through water allocation transfers from an existing license holder, which limits economic expansion in the area. There are also social consequences related to freshwater declines as water distribution disputes can lead to regional and international conflicts (Postel and Wolf 2009).

In order to face these water issues and promote more sustainable water use, changes need to be implemented in sectors with high water consumption. Agricultural production depends heavily on adequate access to water, and a vast quantity of water is required for the United States' agricultural industry. Agricultural uses accounted for 80% of the United States' total water consumption and for more than 90% of the water consumed in many western states, most of this is used for irrigation

(USDA-ERS 2016). As a consequence, traditional water sources such as wells drawing from underground aquifers, reservoirs, and rivers 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 solution to water conservation efforts worldwide is using non-traditional sources of irrigation water such as recycled water from wastewater treatment plants. Recycled water is highly treated wastewater from sources like domestic sewage, industrial wastewater, and storm water runoff (California Department of Water Resources n.d.). There are many benefits of reuse water as a sustainable alternative water supply. Water reuse typically uses less energy than importing water (Sheikh 1998). Reusing water also reduces the amount of treated wastewater that is released, which is especially important in sensitive or impaired surface waters (Miller 2006; Sheikh 1998).

Recycled water is a solution that is being researched and implemented worldwide. In Israel, limited freshwater availability as well as repeated cycles of multi-year droughts motivated innovation in non-traditional water sources (Dreizin 2006). Israel now leads the world in use of non-traditional water for agriculture and has used it successfully in food-crop irrigation for more than 30 years. For instance, in 2012, Israel's total effluent reuse was 85% (Israeli Water Authority 2015), which significantly abated the deficit of freshwater supplies (Becker and Ward 2015; Tenne 2010).

While other studies have used surveys and hypothetical questions, 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 products associated with recycled water. Our field experiments provide insight into both behavioural responses and willingness to pay (WTP) for agricultural products when the same information about the benefits of recycled water are 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, and non-profit organizations) in increasing the acceptability of recycled water products?

We provide a summary of key results in Table 1. Our results indicate that individual behaviour can be influenced by a two-stage decision process explained using a hurdle model. Particularly, we find that the scientists messenger reduces participants' willingness to bid on products irrigated with recycled water relative to other kinds of messengers. The opposite is true for participants who chose to place a bid – once they crossed the lower-limit hurdle of placing a bid, receiving information from the scientists messenger resulted in a greater WTP for products associated with recycled water than when the information came from other messengers. Furthermore, when considering use of recycled water, we find that participants were willing to pay relatively more for non-food products than for food products. Understanding how people respond to different messengers has important implications for agricultural and environmental policies. 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 and cost effective practices by broader sections of the public.

Table 1: Hypotheses testing summarizing key results.

Conjecture	Hypotheses	Result
We anticipate that product type will impact bidding behaviour.	H_0: $bid_{recycled}=bid_{conventional}$ H_1: $bid_{recycled} \neq bid_{conventional}$	Wilcoxon match-pair signed-rank test: Strawberries: *Cannot Reject H_0 ($p > 0.10$)* Shirts: *Cannot Reject H_0 ($p > 0.10$)*
	H_0: $bid_{recycled}=bid_{unspecified}$ H_1: $bid_{recycled} \neq bid_{unspecified}$	Strawberries: *Cannot Reject H_0 ($p > 0.10$)* Shirts: *Cannot Reject H_0 ($p > 0.10$)*
	H_0: $bid_{conventional}=bid_{unspecified}$ H_1: $bid_{conventional} \neq bid_{unspecified}$	Strawberries: *Cannot Reject H_0 ($p > 0.10$)* Shirts: *Cannot Reject H_0 ($p > 0.10$)*
We anticipate that the newspaper messenger treatment will impact bidding behaviour.	H_0: $bid_{newspapers}=bid_{control}$ H_1: $bid_{newspapers} \neq bid_{control}$	Hurdle model - Selection: *Reject H_0,* $bid_{newspapers} > bid_{control}$ *($p < 0.10$)* Hurdle model - Outcome: *Reject H_0,* $bid_{newspapers} > bid_{control}$ *($p < 0.01$)* Difference-in-difference model: *Reject H_0,* $bid_{newspapers} > bid_{control}$ *($p < 0.10$)*
We anticipate that the scientists messenger treatment will impact bidding behaviour.	H_0: $bid_{scientists}=bid_{control}$ H_1: $bid_{scientists} \neq bid_{control}$	Hurdle model - Selection: *Reject H_0,* $bid_{scientists} < bid_{control}$ *($p < 0.01$)* Hurdle model - Outcome: *Reject H_0,* $bid_{scientists} > bid_{control}$ *($p < 0.05$)* Difference-in-difference model: *Cannot Reject H_0 ($p > 0.10$)*
We anticipate that the government agencies messenger treatment will impact bidding behaviour.	H_0: $bid_{government}=bid_{control}$ H_1: $bid_{government} \neq bid_{control}$	Hurdle model - Selection: *Cannot Reject H_0 ($p > 0.10$)* Hurdle model - Outcome: *Reject H_0,* $bid_{government} > bid_{control}$ *($p < 0.05$)* Difference-in-difference: *Cannot Reject H_0 ($p > 0.10$)*
We anticipate that the non-profit organizations messenger treatment will impact bidding behaviour.	H_0: $bid_{non-profit}=bid_{control}$ H_1: $bid_{non-profit} \neq bid_{control}$	Hurdle model – Selection: *Reject H_0,* $bid_{non-profit} > bid_{control}$ *($p < 0.05$)* Hurdle model - Outcome: *Reject H_0,* $bid_{non-profit} > bid_{control}$ *($p < 0.10$)* Difference-in-difference model: *Cannot Reject H_0 ($p > 0.10$)*

We anticipate that gender has an effect on the difference in WTP for recycled and conventional irrigation water products.	H_0: $bid_{female} = bid_{male}$ H_1: $bid_{female} \neq bid_{male}$	Difference-in-difference model: *Cannot Reject H_0 ($p > 0.10$)*
We anticipate that age has an effect on the difference in WTP for recycled and conventional irrigation water products.	H_0: age has no effect on bidding behaviour H_1: age has an effect on bidding behaviour	Difference-in-difference model: *Cannot Reject H_0 ($p > 0.10$)*
We anticipate that the type of product (t-shirt or strawberry) has an effect on the difference in WTP for recycled and conventional irrigation water products.	H_0: $bid_{shirt} = bid_{strawberries}$ H_1: $bid_{shirt} \neq bid_{strawberries}$	Difference-in-difference model: *Reject H_0,* $bid_{shirt} > bid_{strawberries}$ *($p \leq 0.01$)*
We anticipate that political affiliation has an effect on the difference in WTP for recycled and conventional irrigation water products.	H_0: $bid_{conservative} = bid_{liberal}$ H_1: $bid_{conservative} \neq bid_{liberal}$	Difference-in-difference model: *Reject H_0,* $bid_{conservative} < bid_{liberal}$ *($p < 0.01$)*
	H_0: $bid_{moderate} = bid_{liberal}$ H_1: $bid_{moderate} \neq bid_{liberal}$	Difference-in-difference model: *Reject H_0,* $bid_{moderate} < bid_{liberal}$ *($p < 0.10$)*
	H_0: $bid_{other} = bid_{liberal}$ H_1: $bid_{other} \neq bid_{liberal}$	Difference-in-difference model: *Cannot Reject H_0 ($p > 0.10$)*

This paper will be structured in the following way: Chapter 2 will discuss the relevant literature surrounding the topic. This will be followed by the experimental design in Chapter 3, which explains the set up for this experiment and analysis. Chapter 4 will discuss the results, first examining the descriptive results in section 4.1 followed by the regression results in section 4.2. This paper will conclude with a summary of the findings and potential policy implications in Chapter 5.

Chapter 2 Literature Review

As previously stated, most of the research that has been conducted on the effects of public trust in messengers related to the perceptions of environmental products have used survey and hypothetical question methods. 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, departments of health and of the environment, and Friends of the Earth, followed by organizations such as the Environment Agency, Greenpeace, quality newspapers, and government scientists. 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.

Through interviews and surveys, Haynes et al. (2007) examined trust in scientists, government authorities, and a risk-management team during a volcanic event in the West Indies island of Montserrat. They found that government authorities placed a large amount of trust in the scientists as experts in their particular fields. Members of the public also put most of their faith in the scientists, noting that people had died in a 1997 volcanic event on the island after ignoring warnings by scientists. While the scientists were viewed as highly competent and honest because of their impartial stance, information supplied by the government was viewed as politically motivated. On a five-point Likert scale, most of the participants rated friends as the most trustworthy (4.24), followed by scientists (3.94), the local radio station (3.91), the emergency operations center (3.77), and the Montserratian government (3.03).

In research closely related to our study, 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 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 the 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%), and 6% viewed none of the messengers as trustworthy. Leiserowitz et al. (2012) identified a similar trend. They examined the impact of the 2009 "Climategate" controversy 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, they found that trust in scientists as a source for accurate information about global warming had dropped approximately 9%.

Another issue to consider is that using treated, recycled water for irrigation is a new technology, and therefore, only a few agricultural producers in the United States have adopted it despite its value as a cost-effective and sustainable way to irrigate crops (Gleick 2010). Their reluctance is likely related, at least in part, to concerns about how consumers will react to food that is produced with recycled water. Cusimano et al. (2015), for example, reported that farmers were reluctant to use recycled water because of 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, 2016b). In a recent study, Xu et al. (2018) compared consumers' responses to various products irrigated with conventional and recycled water and found that participants overall 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 of 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; they readily accepted using treated wastewater for irrigating public parks and playgrounds but were much less accepting of it for drinking and cooking at home. Rock et al. (2012) similarly found that 67% of Arizona residents supported recycled irrigation water for inedible crops while only 28% supported it for edible crops. Looking specifically at WTP for recycled water in Greece, Menegaki et al. (2007) showed that producers were willing to pay 55% of the price of freshwater for recycled water for irrigation of olive trees and tomatoes. Consumers' mean WTP for olive oil produced from trees irrigated with recycled water was 88% of the market price for olives produced using freshwater.

One way to counter negative perceptions of recycled water and thus substantially improve consumers' WTP is to provide information about its safety. Bakopoulou et al. (2008), for example, concluded that consumers would pay more for products that had been irrigated with recycled water when they received a sufficient amount of information about the processes associated with reusing water. In the United States, consumers generally know little about agricultural technologies so it is important to determine how best to provide information about recycled water as it can be a safe and sustainable irrigation method (Bastian and Murray 2012).

Another issue to be aware of is the existence of environmental price premiums. Although disgust can result in lower WTP for some products, on the other hand, some people are willing to pay price premiums for certain environmentally friendly and sustainably grown products (see Ferraro et al. 2005). In a study by Vecchio and Annunziata (2015), the authors found that WTP for environmentally sustainable-labeled products increased with age, household income, and was higher for females. However, Bazoche et al. (2008) studied wine consumers' WTP for environmental characteristics, specifically wine with reduced pesticide use, and found that consumers did not value environmentally friendly wines more when they isolated the environmental effect from the health effect.

It is important to consider that demographics can influence WTP related to recycled water products. Menegaki et al. (2007) found that younger people were more likely to consume tomatoes irrigated with recycled water. However, Fielding et al. (2015) found the opposite effect of age; they found that older people were more comfortable with using recycled water for irrigation. While some research has shown that women have a higher WTP for environmentally friendly products, other research has found that females had more negative attitudes towards recycled water as well as a lower tolerance for risk and disgust than males (Dolnicar and Schaefer 2009; Fielding et al. 2015; Po et al. 2005).

Researchers have also found impacts of demographic variables on trust. Vainio et al. (2017) studied the associations between trust and perceived risk related to nuclear energy and climate change mitigation. They found that trust varied by respondents' political affiliation, household income, and gender; and that increased education was associated with an increased trust of government sources. Although education will not be used as an explanatory variable in this study, it is important to research other contexts related to trust in order to thoroughly understand this topic. Po et al. (2005) found that people with lower education were less trusting of authorities. Around issues of genetically modified foods, Huffman et al. (2004) found that well-educated individuals were more likely to trust an independent third-party to provide verifiable information than other groups which included government, environmental or consumer groups, private industry, none of the sources, and other sources. They also found that participants informed about the issue of genetically modified foods were more likely to trust government sources relative to a third-party source and that a strict religious upbringing impacted participants' trust of certain organizations. Dolnicar and Hurlimann (2010) found that participants with a higher education level were more strongly influenced by government and scientific sources. 20% of participants without a college degree were not influenced by anyone, whereas this number dropped to 7% for those with a postgraduate degree. Arbuckle et al. (2015) found that farmers who believe in human-induced climate change are more likely to trust government action on greenhouse gas emissions. In the Leiserowitz et al. (2012) study that examined the decline of trust in scientists for climate change information following "Climategate", Democrats were less likely to lessen their trust in scientists than any other political party. Those with an egalitarian worldview were also less likely to lose trust in scientists than those with an individualistic worldview. In another study, trust in science and the government were found to be positive predictors of comfort with drinking recycled water (Fielding et al. 2015).

Chapter 3 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). This present study used the BDM method in a framed field experiment. While there is less control in field experiments than laboratory settings, field experiments have the advantage of being more of a real-world setting (Lusk et al. 2001). The BDM method was used to elicit participants' WTP for two types of 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 irrigated with conventional water, (2) t-shirts made from cotton irrigated with recycled water, (3) cotton t-shirts 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) they would pay for each product, j (Equation 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. 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 truncated from below at \$0 and from above at \$15.

The BDM auction method is considered incentive compatible because it is in the best interest of the individual to bid their true WTP (Irwin et al. 1998; see Appendix A for a schematic representation of the incentive compatible nature of the BDM)[1]. A formal proof that demonstrates the incentive-compatibility of the BDM can be shown (Irwin et al. 1998). Assuming that participants maximize expected utility (EU), and $U(Y)$ represents utility, the bids they submit will be the result of maximizing EU:

$$EU = \int_0^B p(R)U(Y^\circ + E + V - R)dR + \int_B^E p(R)U(Y^\circ + E)dR \quad (2)$$

where V represents the participants' true value of the good, Y° is the initial income, E is the initial money provided in the experiment, and $p(R)$ is the probability that R is randomly selected. In this equation, the first and second integrals capture expected utility for R from 0 to B and B to E, respectively. In order to maximize expected utility, the derivative of EU with respect to B is set equal to zero (Equation 3):

$$\frac{dEU}{dB} = p(B)U(Y^\circ + E + V - B) - p(B)U(Y^\circ + E) = 0 \quad (3)$$

$$\frac{dEU}{dB} = p(B)\ [U(Y^\circ + E + V - B) - U(Y^\circ + E)] = 0 \quad (4)$$

$$U(Y^\circ + E + V - B) = U(Y^\circ + E) \quad (5)$$

[1] Corrigan and Rousu (2008) concluded that the BDM method is consequential since participants understood that the auction is demand revealing and the outcome of decision-making is direct and immediate for participants.

$$\therefore V = B \tag{6}$$

Assuming $p(B) > 0$, Equations 3 through 6 imply that the maximum EU occurs when $B = V$; it is optimal for an individual to submit a bid that is equal to their true value for the product.

There are many additional benefits of using the BDM auction method. BDM auctions have been shown to be useful for eliciting values in field settings since participants' bids are compared to a random number instead of other participants' bids (Lusk et al. 2001; Rousu et al. 2005), as would be the case for first, second, or *n*th-price auctions where multiple people simultaneously making decisions are required. Participants are also not as prone to competition or collusion because they are bidding against a random number (Bougherara and Combris 2009). The BDM is a beneficial method to use since it offers control over payoffs and initial information provided (Irwin et al. 1998). 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 behaviour in such auctions[2]. In our experiment, we provided five practice rounds before the participants placed their bids. Each round 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.

[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.

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 B for more details): (a) newspapers, (b) government agencies, (c) scientists, and (d) non-profit organizations. In the newspaper treatment, for example, the messenger, providing information and an associated link on the benefits of using recycled irrigation water, would be described as a "newspaper article:"

"*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' behaviour varied in terms of bidding.

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 United States mid-Atlantic region. Combined, these 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 establishment entrance 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 training/practice session involving the five multiple-choice questions designed to familiarize them with the BDM mechanism (the instructions and practice questions are provided in Appendix C and the training questions are shown in Appendix D). 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 opportunities to bid on strawberries and three other opportunities to bid on t-shirts—one for each water condition (conventional, recycled, and no information)—that were presented in random order (for the overall order and presentation of the experiment see Appendix D).

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 (choosing not to bid) to a maximum of $15. Once the bidding was completed, the participants also completed a brief survey (Appendix E) that collected demographic information. Finally, the computer program randomly selected one of the rounds for implementation and established the product's price, determining the product purchased by winning bidders and the participants' net earnings.

Chapter 4 Results

4.1 Descriptive Results

Table 2 presents a summary of the demographic characteristics of the 201[3] individuals represented in the sample. 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. For further analysis on the balance of these demographic characteristics across treatments see Appendix G. Additional information was collected through the survey that is not used in the regression analyses but is used to gain a better understanding of the participants' characteristics and personal perceptions (also shown in Table 2).

Table 2: Summary of survey responses including respondents' demographics.

Summary	**Categories**	**Number (%)**
Gender (N=197)		
	Female	118 (60%)
	Male	79 (40%)
	Other	0 (0%)

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

Age (N=195)		
	Mean	44
	Minimum	18
	Maximum	92
Political Affiliation (N=196)		
	Conservative	39 (20%)
	Liberal	60 (31%)
	Moderate	79 (40%)
	Other	18 (9%)
Income (N=195)		
	Less than $10 000	24 (12%)
	$10 000–$14 999	11 (6%)
	$15 000–$24 999	22 (11%)
	$25 000–$34 999	20 (10%)
	$35 000–$49 999	21 (11%)
	$50 000–$74 999	36 (18%)
	$75 000–$99 999	20 (10%)
	$100 000–$149 000	23 (12%)
	$150 000–$199 999	6 (3%)
	$200 000–$249 999	5 (3%)
	$250 000 and above	7 (4%)
Education (N=196)		
	Grade School	2 (1%)
	Some High School	10 (5%)
	High School Graduate	48 (25%)
	Some College	46 (23%)
	Associate Degree	19 (10%)
	Bachelor's Degree	39 (20%)
	Graduate Degree/Professional	32 (16%)
Employment (N=197)		
	Education	12 (6%)
	Business	33 (17%)
	Government	24 (12%)
	Agriculture	5 (3%)
	Healthcare	22 (11%)
	Student	34 (17%)
	Other	67 (34%)
Children under 18 years in the household (N=196)		
	Yes	73 (37%)
	No	123 (63%)

Primary shopper in the household (N=197)		
	Yes	132 (67%)
	No	65 (33%)
How often do you consume fruit per month? (N=195)		
	0-5	40 (21%)
	6-10	33 (17%)
	11-15	28 (14%)
	16-20	23 (12%)
	21-25	13 (7%)
	26-30	36 (18%)
	30+	22 (11%)
Do you grow your own food? (N=198)		
	Yes	30 (15%)
	No	168 (85%)
Which do you prefer? (N=199)		
	Local food	134 (67%)
	Non-local food	5 (3%)
	Do not care	60 (30%)
What is the percentage of organic foods in your overall vegetable and fruit consumption? (N=200)		
	0-10	35 (18%)
	11-20	24 (12%)
	21-30	26 (13%)
	31-40	25 (13%)
	41-50	39 (20%)
	51-60	8 (4%)
	61-70	13 (7%)
	71-80	17 (9%)
	81-90	9 (5%)
	91-100	4 (2%)
Do you prefer clothing made from organic cotton? (N=200)		
	Yes	59 (30%)
	No	35 (18%)
	Do not care	106 (53%)
Do you educate yourself about how your clothing is produced? (N=199)		
	Yes	70 (35%)
	No	129 (65%)

What type of water do you typically drink? (N=200)		
	Bottled	37 (19%)
	Tap	62 (31%)
	Filtered	99 (50%)
	Other	2 (1%)
Do you think millennials are more likely to prefer using recycled water for crop irrigation? (N=197)		
	Yes	104 (53%)
	No	33 (17%)
	Not sure	60 (30%)
Do you think individuals in your community are more likely to prefer using recycled water for crop irrigation? (N=197)		
	Yes	88 (45%)
	No	49 (25%)
	Not sure	60 (30%)
Do you think the majority of consumers prefer using recycled water for crop irrigation? (N=197)		
	Yes	65 (33%)
	No	69 (35%)
	Not sure	63 (32%)
Do you prefer conventional water or recycled water for use in food crop production? (N=197)		
	Conventional	62 (31%)
	Recycled	83 (42%)
	Do not care	52 (26%)
Do you prefer conventional water or recycled water for use in non-food crop production? (N=198)		
	Conventional	80 (40%)
	Recycled	59 (30%)
	Do not care	59 (30%)

Are you concerned about water availability in these areas?		
Your Community (N=200)		
	Yes	118 (59%)
	No	82 (41%)
Your state (N=199)		
	Yes	120 (60%)
	No	79 (40%)
United States (N=200)		
	Yes	154 (77%)
	No	46 (23%)
Worldwide (N=198)		
	Yes	178 (90%)
	No	20 (10%)
How concerned are you about climate change in these areas?		
Your community (N=200)		
	Not at all (1)	19 (10%)
	(2)	22 (11%)
	(3)	36 (18%)
	(4)	62 (31%)
	Very concerned (5)	61 (31%)
Your state (N=200)		
	Not at all (1)	18 (9%)
	(2)	16 (8%)
	(3)	41 (21%)
	(4)	61 (31%)
	Very concerned (5)	64 (32%)
United States (N=200)		
	Not at all (1)	10 (5%)
	(2)	14 (7%)
	(3)	30 (15%)
	(4)	49 (25%)
	Very concerned (5)	97 (49%)
Worldwide (N=199)		
	Not at all (1)	11 (6%)
	(2)	7 (4%)
	(3)	35 (18%)
	(4)	37 (19%)
	Very concerned (5)	109 (55%)

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.

Our study included participants with a range of employment backgrounds; for example including business, government, and students. 37% of respondents had children under the age of 18 in their household and 67% stated that they were the primary shopper of their household. The sample was split on how often fruit was consumed per month; individual unit responses for this question were grouped into categories. The highest category was 0-5 times per month, which contained 21% of the sample and the next most common category with 18% of respondents was 26-30 times per month. Only a small portion of people in the study, 15%, grow their own food; however, the majority, 67%, prefer local food. Respondents were also asked what percentage of their overall fruit and vegetable consumption was organic. Their responses were condensed into categories of 10. The majority of responses were under 50% organic with the top categories of 41-50% organic, which contained 20% of the sample followed by 18% of respondents in the 0-10% organic category.

Most respondents, 53%, stated "Do not care" when asked if they had a preference for clothing made from cotton and the majority, 65%, also said they did not educate themselves about how their clothing is produced. 50% of people in the study said they drink filtered water, followed by 31% who said they drink tap water. 53% of participants thought millennials were more likely to prefer recycled water for crop irrigation. When participants were asked if they thought individuals in their community were more likely to prefer using recycled water for crop irrigation, 45% responded "Yes" and 25% responded "No", while the remaining were uncertain. When asked a similar question instead about the majority of consumers preferring recycled water, only 33% responded "Yes" and the "No" responses increased to 35%. Participants were also asked about their own preferences for using recycled water for irrigation. 42% stated a preference for recycled water for use in food crop production, 31% preferred conventional water, and 26% did not care. In response to a similar question regarding non-food crop production, the portion of respondents who preferred recycled water dropped to 30% and preference for conventional rose to 40%. Participants were concerned about water availability to varying degrees for different areas. More specifically the larger the scale presented, the more concerned about water availability they were (59% were concerned at their community level compared to 90% on a worldwide level). Similarly, respondents were increasingly concerned about climate change as the area presented increased; 31% stated that they were very concerned about climate change in their community, up to 55% stating very concerned about climate change worldwide.

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), the results of which are summarized in Figure 2. 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 highest portion of responses for trusting newspapers, non-profit organizations, and government agencies was in the middle response, (3), between strongly disagree (1) and strongly agree (5).

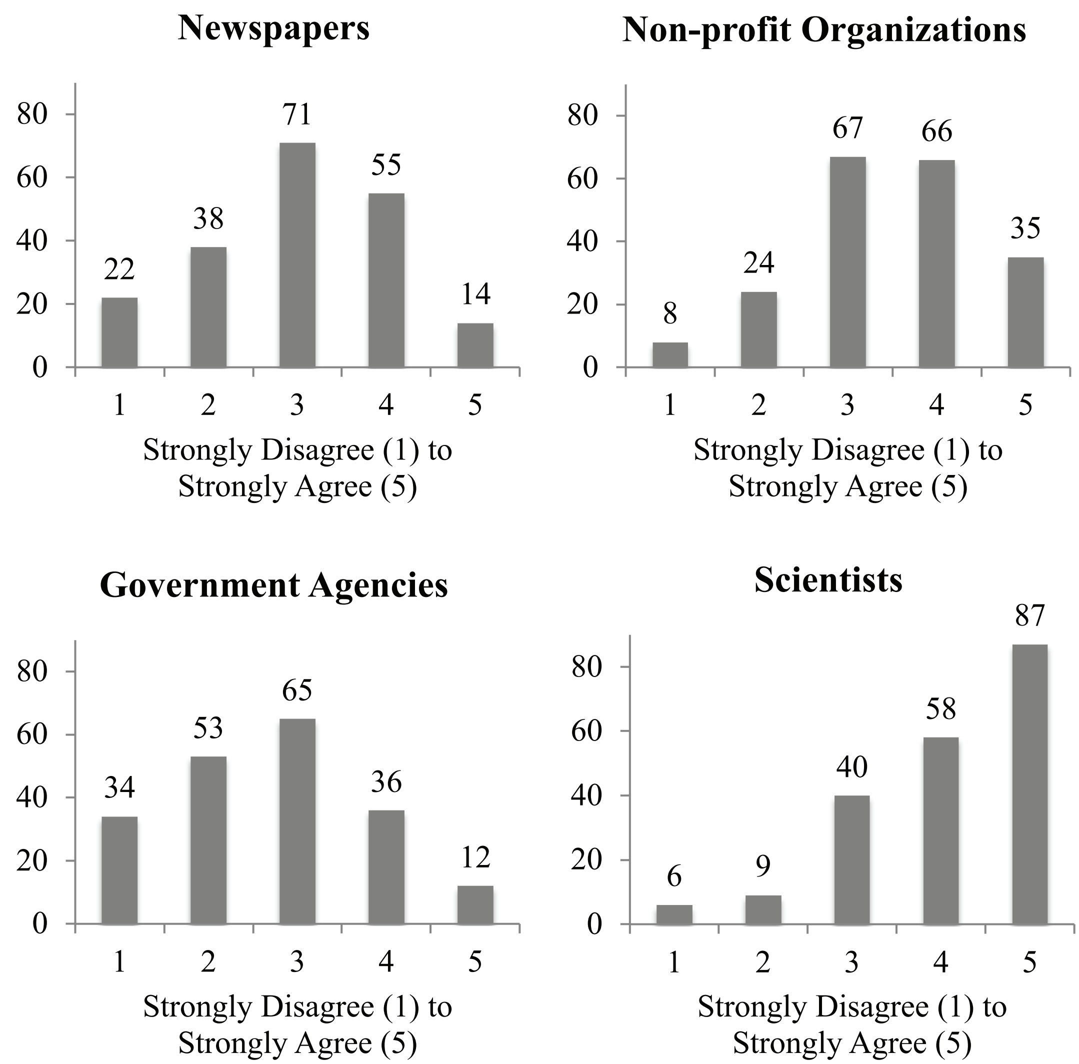

Figure 2: Summary of survey responses to trust associated with different messengers. Strongly disagree refers to participants distrust in the messenger while strongly agree refers to trusting the source.

Table 3 reports how participants responded to practice questions, which were designed to familiarize them with the BDM auction. Most individuals (82%) correctly answered the first quiz question. However, interestingly and surprisingly, there is a slightly decreasing trend in terms of correctness. Specifically, the first question yielded the highest number of correct answers, followed by the second question through the last question in a monotonically descending order. It is beyond the scope of this research to identify the underlying reasons for such behavioural pattern, as it may be explained by fatigue, loss of interest, or simply that the questions could appear to have different difficulty levels to the participants. However, this raises an interesting question for future research in determining what the optimal training intensity for participants is in experimental auctions.

Table 3: Percentage of correct answers to each practice questions (N=201).

Practice Question Number	Correct Answers (Percentage)
1	165 (82.1%)
2	158 (78.6%)
3	139 (69.2%)
4	129 (64.2%)
5	126 (62.7%)

Figure 3 presents histograms for the bids made for each of the products. One might anticipate that because a t-shirt has a higher average market price than a package of strawberries, the bids for the t-shirt products are generally higher overall. The histograms show that the bids for all of the products are right-skewed—most of the responses were between \$0 and \$7.

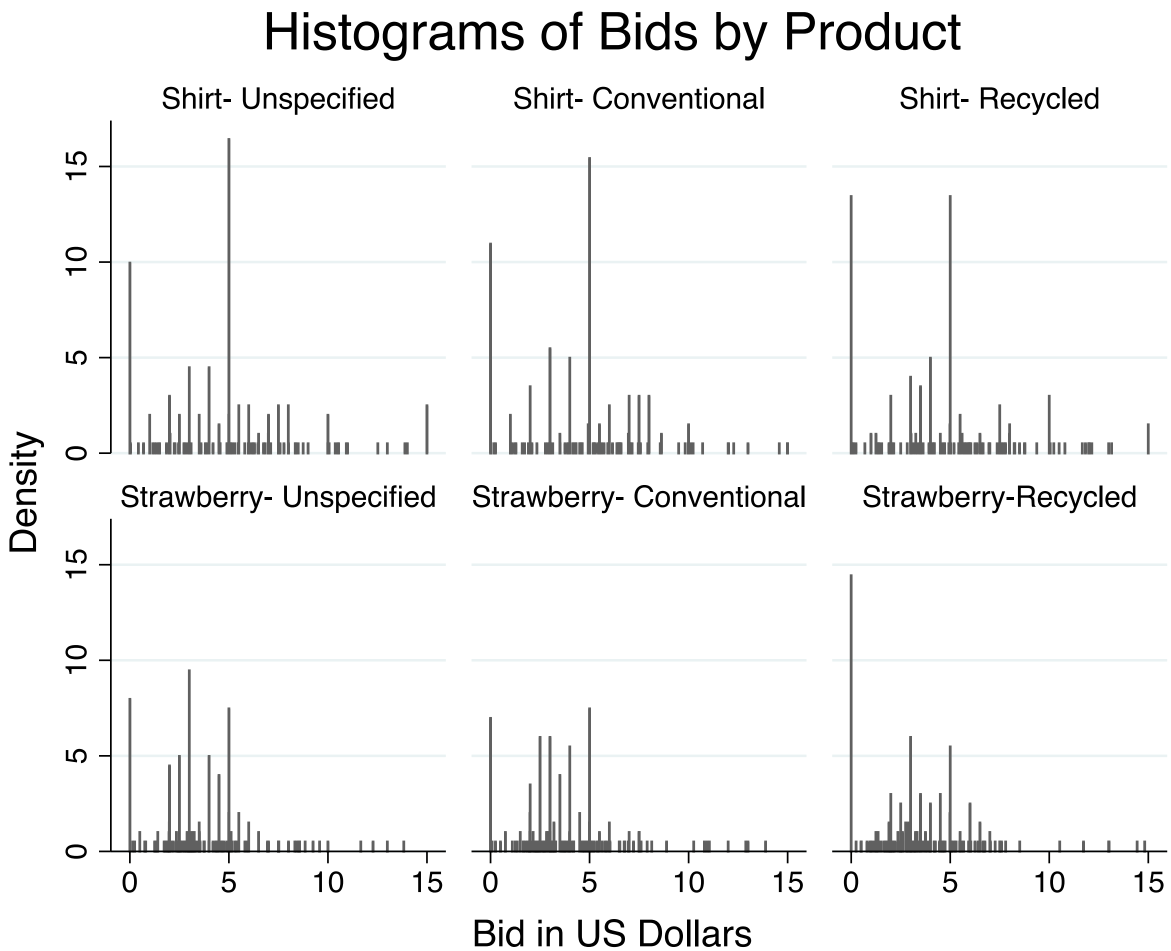

Figure 3: Histograms of bids separated by product type (t-shirt or strawberry) and type of irrigation water (unspecified, conventional, or recycled).

Figure 4 shows mean bids for each product type and messenger treatment. Again, as expected, the average bids for t-shirts are higher than the average bids for strawberries. The mean bid over all of the products and treatments is $4.23. A comparison of the bids for t-shirts shows means of $4.94 for no irrigation water specification, $4.75 for conventional water, and $4.74 for recycled water. The results for the strawberries are similar: mean bids of $3.69 for no water specification, $3.79 for conventional water, and $3.48 for recycled water. Next, we analyze the potential effects of the messengers. We find that the newspapers treatment produces the highest overall bids with a mean of $4.69 and the scientists treatment produces the lowest with a mean of $3.72. We used a Shapiro-

Wilk test to further show that the data is not normally distributed (p-value<0.01). Therefore, to compare individual bids made for products based on the water information provided, we use a nonparametric Wilcoxon match-pair signed-rank test. The results of this test indicate that there are no statistically significant differences between bids on the products under the no-information, conventional, and recycled water specifications[4].

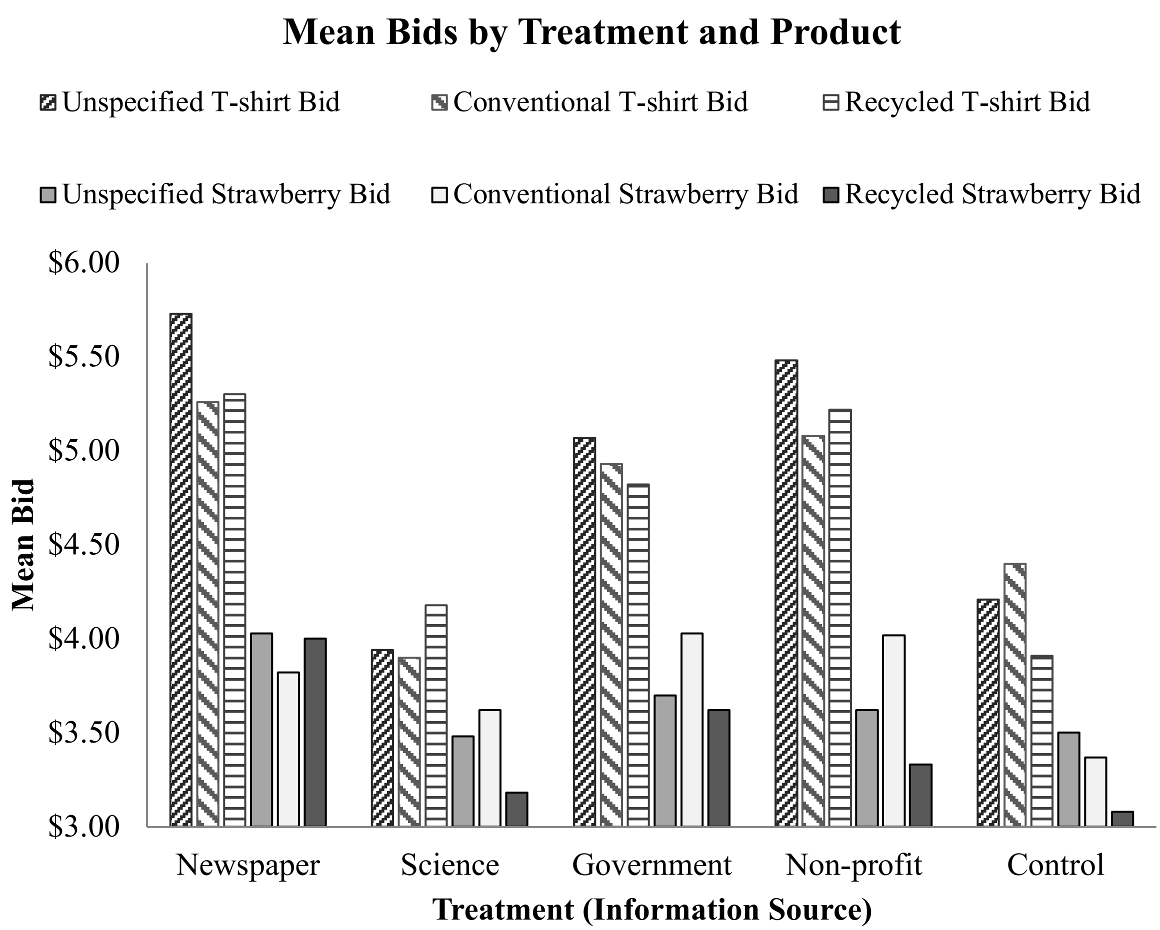

Figure 4: Summary of mean bids by messenger treatment and product type.

[4] While the Wilcoxon tests suggests no overall significant difference between 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 the disgust response; this is similar to the findings of Bakopoulou et al. (2008) who found that providing information about the process of recycling water increased WTP for products irrigated with recycled water.

4.2 Regression Results

We use 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. Recall that the results we present in Figure 3 show a large number of $0 bids, which indicate that a number of participants chose not to bid for particular items. 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 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 used; therefore, we do not use upper censoring in our analysis.

Also note that only three participants[5] 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

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

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 mainly distanced from production processes now, they may have become increasingly concerned about the ethical, social, and environmental impacts of both food and clothing production (Messer et al. 2015). Evidence of consumer desire for more transparency and labelling was also demonstrated when Vermont passed mandatory GMO labelling legislation in 2014. 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.

In this study, we use 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 the 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 (Equation 7), 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).

Equations 7 and 8 are the participation equations that estimate the selection portion of the hurdle

$$Prob\left[y_{ij}^* > 0\right] = \phi\left(x_{ij}'\gamma\right), \ z_{ij} = 1 \ if \ y_{ij}^* > 0 \quad (7)$$

$$Prob\left[y_{ij}^* \leq 0\right] = 1 - \phi\left(x_{ij}'\gamma\right), \ z_{ij} = 0 \ if \ y_{ij}^* \leq 0 \quad (8)$$

$$E\left[y_{ij} \middle| z_{ij} = 1\right] = x_{ij}'\beta + \sigma\lambda_{ij} \quad (9)$$

model – whether a respondent chose to participate in the auction by placing a positive bid (a binary choice model). Equation 9 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 (truncated, continuous model).

The results of the hurdle model indicate that the nature of the messenger has a significant effect on participants' behaviour for all products, as shown in Table 4[6]. However, the coefficients for the scientists treatment show stark differences between choosing whether to bid and the amount of the bid. The scientists messenger coefficient in the selection model is negative and significant; participants who receive that treatment are significantly less likely to place a bid on a product. In the outcome model, the reverse is true. On average, participants who cross the zero-hurdle submit a bid that is significantly higher than the participants in the no-information control treatment. Participants under the other three messenger treatments are more likely to place a positive bid and bid higher amounts than participants under the control treatment. While all treatments result in greater WTP compared to the control in the outcome model, the newspaper treatment coefficient has the largest magnitude.

[6] This 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.

Table 4: Results from the hurdle model examining the effects of messenger treatments on participants' WTP compared to the no information control treatment.

Bid	Coefficient	Standard Error	p-Value
Selection Model			
Newspapers	0.2853*	0.1652	0.084
Scientists	–0.4965***	0.1474	0.001
Government Agencies	0.1449	0.1651	0.380
Non-profit Organizations	0.3676**	0.1772	0.038
Control		(omitted)	
Constant	1.2381***	0.1172	0.000
Outcome Model			
Newspapers	1.2034***	0.3939	0.002
Scientists	0.9386**	0.4261	0.028
Government Agencies	0.8467**	0.4110	0.039
Non-profit Organizations	0.7837*	0.4088	0.055
Control		(omitted)	
Constant	3.2197***	0.3340	0.000

Notes: N = 1206; Prob > Chi^2 = 0.0000; *, **, *** denote significance at a 10%, 5%, and 1% level, respectively.

A Wald joint hypothesis test is used to test the overall significance of the model; the treatment coefficients in both the selection and outcome models are tested. We test if the treatments in general are significant by testing if the treatment coefficients are simultaneously zero (StataCorp 2015). 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 behaviour of respondents. In this study if the message, the positive information statement, were the major influence on participant behaviour, we would expect the messenger treatments to all 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 behaviour. We also test the equality of the treatment coefficients. We test the hypothesis that all the included treatments have the same coefficient (StataCorp 2015). From this test, we cannot reject equality of the included treatments for the outcome model (p-value=0.6441); however, we can reject equality of treatment coefficients in the selection model (p-value=0.0000) and conclude that the coefficients are not all the same[7].

Since we observe that the scientist messenger treatment produces results that partially deviate from participants' stated trust in scientists from the survey results[8] (Figure 2), we further explore demographic effects on stated trust. Since stated trust, the dependent variable in this second analysis (y_i), is ranked from strongly disagree (1) to strongly agree (5) we use an ordered probit model to account for the ordinal values; age, gender, and political affiliation are included as explanatory variables (x_i') (Equations 10 and 11). 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).

$$y_i^* = x_i'\beta + \varepsilon_i \tag{10}$$

$$y_i = \mu \; if \; \gamma_{\mu-1} < y_i^* \leq \gamma_\mu \tag{11}$$

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 5). We also find that the probability of participants selecting strongly disagree to trusting information from scientific sources (1) increases and the probability of strongly agree (5) decreases when a respondent states conservative,

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[7] We also tested equality among pairs of the coefficients. For the outcome model, the order of comparisons were: newspapers and scientists, newspapers and government agencies, newspapers and non-profit organizations, scientists and government agencies, scientists and non-profit organizations, and government agencies and non-profit organizations, which resulted in the following p-values: 0.4807, 0.3197, 0.2387, 0.8156, 0.6928, and 0.8669, respectively. The same order of coefficient comparison was used for the selection model which resulted in the following p-values: 0.0000, 0.3937, 0.6413, 0.0000, 0.0000, and 0.2074, respectively.

[8] Recall, participants stated that they trusted scientist more than newspapers, government, and non-profit organizations. However, their behaviour 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.

moderate, or other political affiliation compared to liberal affiliation. Therefore, it appears that the stated preferences – not to trust scientific information – may be driven by political affiliation and age.

Table 5: 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.

The third model we explore is a 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 labeled as produced with recycled water (Bid_r) versus the same product labeled as produced with conventional water (Bid_c) (Equation 12). The independent variables in this case were the treatment dummies as well as the age, gender, and political affiliation of the respondent (Equation 13)[9]. This model also includes a dummy variable to indicate

[9] We attempted to include interactions of treatment variables and demographic characteristics in the difference-in-difference model; however, we chose not to include interactions in our final model in order to present the most meaningful results.

whether the item was a t-shirt or strawberry, which is denoted as k in Equations 12 and 13 and i is the individual.

$$w_{ik} = (Bid_r - Bid_c)_{ik} \tag{12}$$

$$w_{ik} = \alpha_i + \beta_1 * Newspaperdummy_{ik} + \beta_2 * Science_{ik} + \beta_3 * Government_{ik} + \beta_4 * Nonprofit_{ik} + \beta_5 * Gender_{ik} + \beta_6 * Age_{ik} + \beta_7 * Tshirt_{ik} + \beta * Politics_{ik} + \varepsilon_{ik} \tag{13}$$

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

Since bids were truncated 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 product fall within the set (0, 15) (Equation 14; Li et al. 2017). The full relationship of the latent variable, w_{ik}^* is:

$$w_{ik}^* = \begin{cases} w_{ik} = \alpha_i + X\beta + \epsilon_{ik} & \text{If } 0 < Bid_c < 15 \text{ and } 0 < Bid_r < 15 \\ [Bid_r, \infty) & \text{If } Bid_c = 0 \\ (-\infty, -Bid_c] & \text{If } Bid_r = 0 \\ (-\infty, Bid_r - 15] & \text{If } Bid_c = 15 \\ [15 - Bid_c, \infty) & \text{If } Bid_r = 15 \\ (-\infty, \infty) & \text{If } Bid_c = 0 \text{ and } Bid_r = 0 \\ (-\infty, \infty) & \text{If } Bid_c = 15 \text{ and } Bid_r = 15 \\ (-\infty, -15] & \text{If } Bid_c = 15 \text{ and } Bid_r = 0 \\ [15, \infty) & \text{If } Bid_c = 0 \text{ and } Bid_r = 15 \end{cases} \tag{14}$$

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 1,206 at the upper limit of \$15. Bids of \$0, on the other hand, likely reflect participants' rejection of the products. However, the restrictions described in Equation 14, 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 6. They show that, in general, positive information about recycled irrigation water from any type of messenger results in higher relative WTP 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 has 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 find no significant effects for gender and age. There is a statistically significant increase in relative WTP (at the 1% level) when the product is a t-shirt – this is, perhaps, an intuitive finding but it clearly demonstrates the difference in consumers' responses to products they consume (oral contact) versus products they wear (skin contact), that is, they are significantly less concerned if the product is a t-shirt compared to when the product is strawberries. The regression model also shows that the politically conservative and moderate participants' WTP for recycled-water products is lower than the WTP of politically liberal participants on average. The differences are significant at a 1% (conservative) and 6% (moderate) level.

Table 6: Results from difference-in-difference model examining the effects of participants' relative WTP 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.

Chapter 5 Conclusion

The agricultural industry is the single largest consumer of freshwater 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 become a necessity in the future; 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. 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, Messer et al. 2008; Liaukonyte et al. 2013). Furthermore, some recent research has explored individuals' level 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 science 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 those preferences in the context of items produced using recycled wastewater for irrigation. We conclude from our results that messengers can significantly impact consumer behaviour, since we saw all treatments increase WTP in the outcome model of the hurdle analysis. We also find that a messenger carrying information from scientists can lead to conflicting outcomes. Our results show that participants under the scientists-messenger treatment were generally less likely to place a positive bid when compared to the control. However, people in the scientists treatment also placed relatively higher bids if they chose to bid positive amounts in the BDM auction. 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.

The results of the difference-in-difference model confirm findings from previous studies (for example, Po et al. 2005) that showed that the degree of contact with recycled water is an important factor in the acceptance of the process. Our results indicate that 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 stigma 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 behaviours 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. However, this would require a large sample size to properly analyze, as additional treatments would further split the data.

There is a push within 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 the United States in scientists. We find that the decline may be explained by distinctly different behaviours. Some people have perhaps chosen to "turn their heads" from scientists and thus refuse to "place bids" altogether while those who have chosen to place bids view scientific information as important and their behaviour is influenced by it – these are important considerations for future studies and policies.

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Appendix A Visualizations of the BDM auction method

If the individual overstates their WTP (Figure A1, where R represents the random price and E represents the maximum allowed bid which is $15 in this case) and the random price is greater than their true WTP but less than their stated WTP, the individual would be forced to pay more than its value to them.

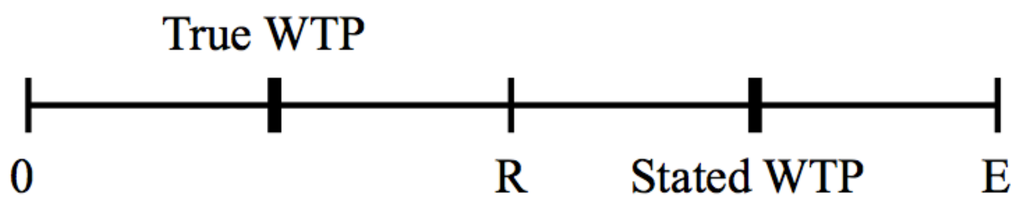


Figure A1: Visualization of the BDM method when the individual's stated WTP (their bid) is higher than their true WTP. This is sub-optimal for the individual.

If the individual understates their WTP (Figure A2) and the random price is less than their true WTP but greater than their stated WTP, then the individual has forgone the opportunity to gain utility from purchasing the product.

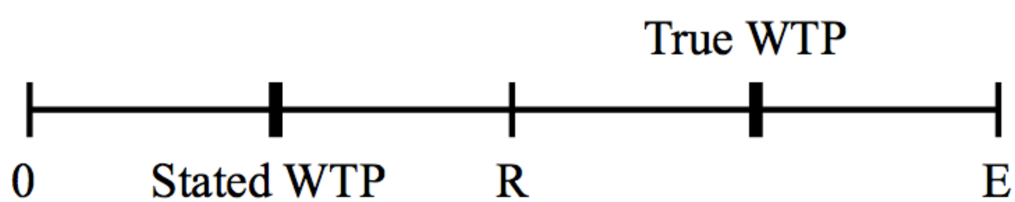


Figure A2: Visualization of the BDM method when the individual's stated WTP (their bid) is lower than their true WTP. This is sub-optimal for the individual.

When an individual's stated WTP matches their true WTP and these values are greater than or equal to the random price (Figure A3), then there is an exchange of goods that is beneficial for the individual.

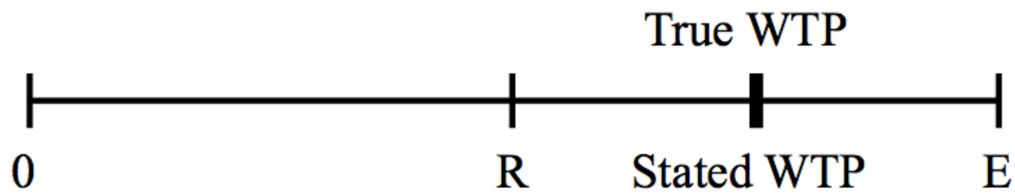


Figure A3: Visualization of the BDM method when the individual's stated WTP (their bid) equals their true WTP and these values are greater than the random price. This is optimal for the individual.

Alternatively, when the stated WTP matches the true WTP but these values fall below the random price (Figure A4), there is no exchange of goods, which is optimal for the individual as the random price exceeds the utility they would gain from purchasing the product. Therefore, participants had an incentive to reveal their true greatest WTP for each item in this study since any deviation would result in a sub-optimal outcome.

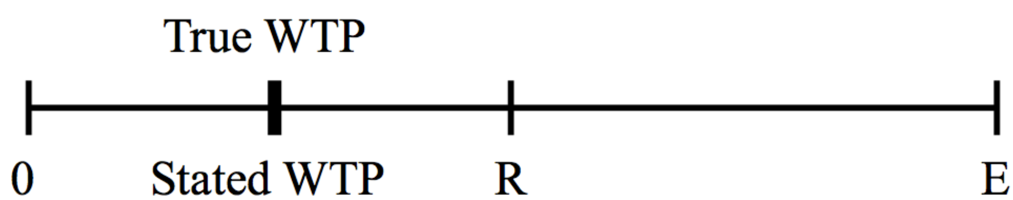
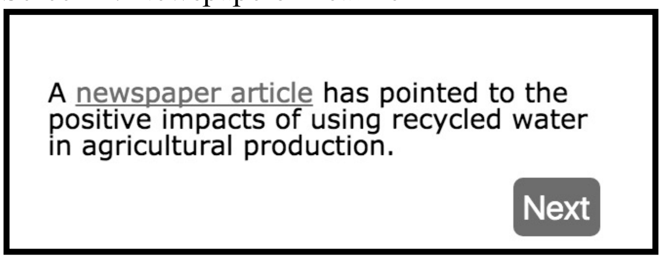


Figure A4: Visualization of the BDM method when the individual's stated WTP (their bid) equals their true WTP and these values are less than the random price. This is optimal for the individual.

Appendix B Details on treatments

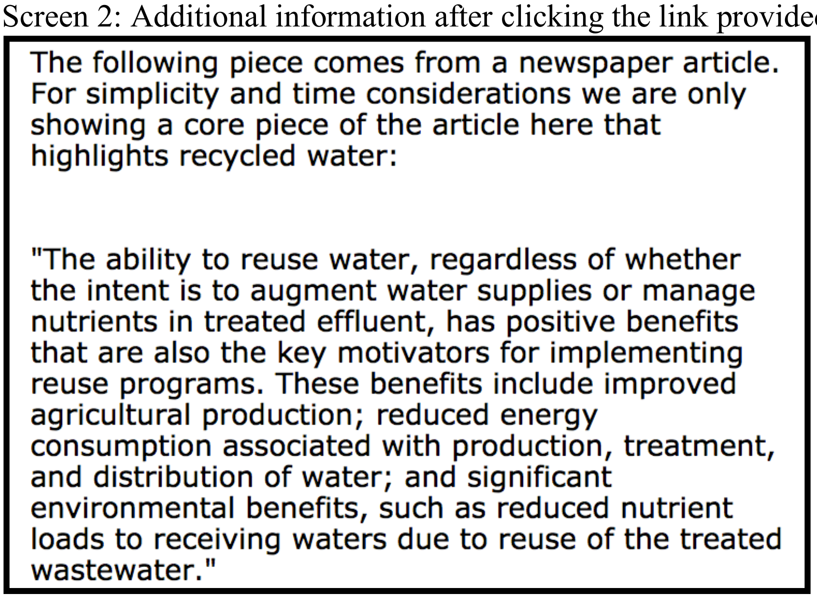
The following images show how the treatment information was presented to participants. After the instructions, practice questions, and definitions of conventional and recycled irrigation water, Screen 1 was displayed which outlined the treatment (here, newspaper article). The other treatments would show the exact same language, except that instead of 'newspaper article' they would say 'scientific study', 'government organization', or 'non-profit organization'.

Screen 1: Newspapers Treatment



If participants clicked the underlined link (see Screen 1), then more information was provided in Screen 2 (below). This additional information was the same for each treatment, only varying by messenger ('newspaper article', 'scientific study', 'government organization', or 'non-profit organization'). If participants chose to not click the link, they would not see the additional information of Screen 2.

Screen 2: Additional information after clicking the link provided in Screen 1



Since deceit is typically not allowed in economic experiments, it was ensured that the positive information presented by each treatment was sourced from that messenger. Although only the excerpt quoted above was shown to participants, this additional information quote can be found in real articles for each source. The quote was initially sourced from an EPA report (Bastian and Murray 2012). For the purposes of this study, this EPA report is considered both a government and a scientists messenger.

This quote was then incorporated into the newspaper and nonprofit treatments. The quote can be found in the University of Delaware newspaper UDaily (Thomas 2016). The nonprofit source for the quote can be found on the website for the Center for Health and Hope (Center for Health and Hope 2016). The following images show how the information is presented by each source.

The sources may be found using the following links:

Scientists and government:	https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf (Bastian and Murray 2012)
Newspaper:	http://www.udel.edu/udaily/2016/may/conserve-water-reuse-051716/ (Thomas 2016)
Nonprofit:	https://www.centerforhealthandhope.org/clean-water-sanitation (Center for Health and Hope 2016)

1.4 Motivation for Reuse

The ability to reuse water, regardless of whether the intent is to augment water supplies or manage nutrients in treated effluent, has positive benefits that are also the key motivators for implementing reuse programs. These benefits include improved agricultural production; reduced energy consumption associated with production, treatment, and distribution of water; and significant environmental benefits, such as reduced nutrient loads to receiving waters due to reuse of the treated wastewater. As such, in 2012, the drivers for reuse are similar to those presented in the 2004 guidelines and center around three categories: 1) addressing urbanization and water supply scarcity, 2) achieving efficient resource use, and 3) environmental and public health protection.

1.4.1 Urbanization and Water Scarcity

The present world population of 7 billion is expected to reach 9.5 billion by 2050 (USCB, n.d.).

In addition to the increasing need to meet potable water supply demands and other urban demands (e.g., landscape irrigation, commercial, and industrial needs), increased agricultural demands due to greater incorporation of animal and dairy products into the diet also increase demands on water for food production (Pimentel and Pimentel, 2003). These increases in population and a dependency on high-water-demand agriculture are coupled with increasing urbanization; all of these factors and others are effecting land use changes that exacerbate water supply challenges. Likewise, sea level rise and increasing intensity and variability of local climate patterns are predicted to alter hydrologic and ecosystem dynamics and composition (Bates et al., 2008). For example, the western United States, including the Colorado River Basin, which provides water to 35 million people, is projected to experience seasonal and annual temperature increases, resulting in increased evaporation (Garfin et al., 2007; Cohen, 2011).

Reuse projects must factor in climate predictions, both for demand projections and for ecological impacts. Municipal wastewater generation in the United States averages approximately 75 gpcd (284 Lpcd) and is relatively constant throughout the year. Where collection systems are in poor condition, the wastewater generation rate may be considerably higher or lower due to infiltration/inflow or exfiltration, respectively. Thus, according to Schroeder et al. (2012), the potential municipal water supply offset by reuse for a community of 1 million people will be approximately 75 mgd (3,950 L/s) or 27,400 million gallons (125 MCM) per year. Given losses at various points in the overall system and potential downstream water rights, the actual available water would most likely be about 50 percent of the potential value, but the resulting impact on the available water supply would still be impressive.

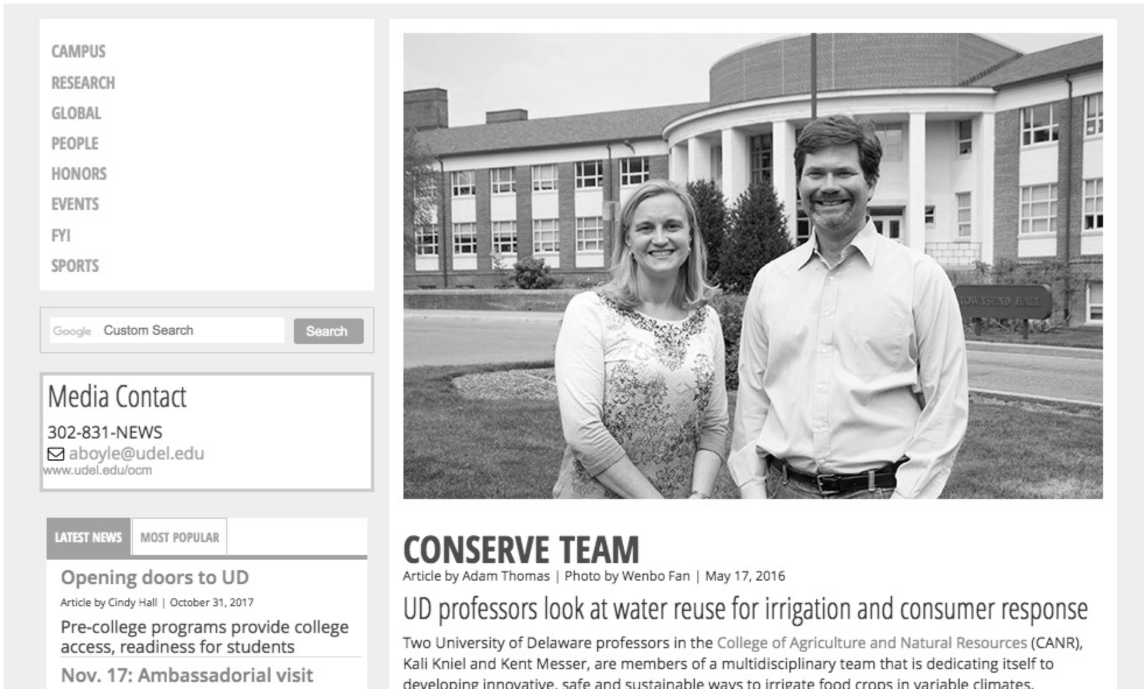
As urban areas continue to grow, pressure on local water supplies will continue to increase. Already, groundwater aquifers used by over half of the world population are being overdrafted (Brown, 2011). As a result, it is no longer advisable to use water once and dispose of it; it is important to identify ways to reuse water. Reuse will continue to increase as the world's population becomes increasingly urbanized and concentrated near coastlines, where local freshwater supplies are limited or are available only with large capital expenditure (Creel, 2003).

1.4.2 Water-Energy Nexus

Energy efficiency and sustainability are key drivers of water reuse, which is why water reuse is so integral to sustainable water management. The water-energy nexus recognizes that water and energy are mutually dependent—energy production requires large volumes of water, and water infrastructure requires large amounts of energy (NCSL, 2009). Water reuse is a critical factor in slowing the compound loop of increased water and energy use witnessed in the water-energy nexus. A frequently-cited definition of sustainability comes from a 1987 report by the Bruntland Commission: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Therefore, sustainable water management can be defined as water resource management that meets the needs of present and future generations.

Water reuse is integral to sustainable water management because it allows water to remain in the environment and be preserved for future uses while meeting the water requirements of the present. Water and energy are interconnected, and sustainable management of either resource requires consideration of the other. Water reuse reduces energy use by eliminating additional potable water treatment and associated water conveyance because reclaimed

Figure A5: The additional information quote displayed to participants if the link for more information was clicked came from this EPA document (Bastian and Murray 2012). This source is considered both a scientist and government messenger. This positive information quote was then incorporated into the other messengers.



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Opening doors to UD
Article by Cindy Hall | October 31, 2017
Pre-college programs provide college access, readiness for students

Nov. 17: Ambassadorial visit

CONSERVE TEAM
Article by Adam Thomas | Photo by Wenbo Fan | May 17, 2016

UD professors look at water reuse for irrigation and consumer response

Two University of Delaware professors in the College of Agriculture and Natural Resources (CANR), Kali Kniel and Kent Messer, are members of a multidisciplinary team that is dedicating itself to developing innovative, safe and sustainable ways to irrigate food crops in variable climates.

Figure A6: The webpage for the UDaily newspaper source appears as shown in the image presented above (Thomas 2016).

Recently, at UD's Ag Day, Messer and his team evaluated whether consumers would actually pay more for food produced with recycled water. They evaluated the consumer response to strawberries, blueberries, spinach, and broccoli produced with and without recycled water.

According to the Environmental Protection Agency (EPA), the ability to reuse water, regardless of whether the intent is to augment water supplies or manage nutrients in treated effluent, has positive benefits that are also the key motivators for implementing reuse programs. These benefits include improved agricultural production; reduced energy consumption associated with production, treatment and distribution of water; and significant environmental benefits, such as reduced nutrient loads to receiving waters due to reuse of the treated wastewater.

"Through the CONSERVE project, we have the opportunity to say, 'Here's some water friendly products. Would you be willing to pay more for them?' If the answer is 'yes,' then this might be a win for the consumers, the farmers, and the environment," said Messer.

Figure A7: The same quote that was found in the EPA 2012 Guidelines for Water Reuse report (Bastian and Murray 2012) is part of the UDaily newspaper article as shown above in the article titled, "UD professors look at water reuse for irrigation and consumer response" (Thomas 2016).

Figure A8: The webpage for the nonprofit source, Center for Health and Hope, appears as shown in the image presented above (Center for Health and Hope 2016).

Urgent Need: Recycled Water

Agricultural production, and therefore food availability, depends on water resources. Depending on the region, agricultural water use accounts for up to 90% of all water consumption (USDA-ERS 2016). Traditional water sources, such as well water from underground aquifers and surface water from reservoirs and rivers, are increasingly impacted by overuse and changing climatic conditions. Hence, future availability and sustainable water-use will likely depend on how the agricultural industry and policy-makers address efforts to conserve water.

A potential solution lies in the use of non-traditional irrigation water, such as recycled gray or treated brown water. Only a few agricultural producers have adopted use of non-traditional irrigation water thus far. A reason why this cost-effective sustainable practice has not been adopted more frequently are concerns about consumer acceptability of agricultural output grown with recycled water, yet this area has not been well studied. According to the EPA's 2012 Guidelines for Water Reuse: *"The ability to reuse water, regardless of whether the intent is to augment water supplies or manage nutrients in treated effluent, has positive benefits that are also the key motivators for implementing reuse programs. These benefits include improved agricultural production; reduced energy consumption associated with production, treatment, and distribution of water; and significant environmental benefits, such as reduced nutrient loads to receiving waters due to reuse of the treated wastewater."* (https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf).

Researchers at the University of Delaware and the University of Alberta are working on understanding how people perceive the risks associate with recycled water – Will people accept the use of these sustainable growing techniques? Will people perhaps even place a higher value on these sustainable practices or will they shun these products?

Figure A9: The same language from the EPA report (Bastian and Murray 2012) is also included on the Center for Health and Hope webpage in an article about recycled water titled, "Urgent Need: Recycled Water" (Center for Health and Hope 2016).

Appendix C Experimental instructions

Instructions:
Please read these instructions carefully. Please do not communicate with other participants. If you have questions, please raise your hand and an administrator will come to you.
In today's study, you will be asked to indicate the *highest amount of money you would pay* for certain products. This amount will be called your bid.
You will receive $15 for participating in this study.
Below we will explain how you can use this money to place bids on certain products.
All decisions you make are real decisions – this means that you will place bids of real money on real products.

Process:
We will ask you to bid the highest amount of money you are willing to pay for a number of products. These products will be on display at the main table.
You will fill out a short survey.
At the end, one of your bids for a product will be randomly selected for implementation.
The computer will draw a random price for the selected product.
If your bid for that product is higher than the random price, you will purchase the product at the random price. If your bid is lower than the random price, you will not purchase any product.
Any purchases you make will be deducted from the $15 you receive for your participation.

Rules for Bidding:
Your bids must be between $0 and $15.
Once you have placed your bids for all the products, the computer will randomly choose one product for implementation.
For the chosen product, the computer will randomly generate a price between $0 and $15.
If your bid for that product is higher or equal to the random price, you will receive the product and pay only the random price.
If your bid is lower than the random price, you will not receive the product and receive the $15.
It is most beneficial for you to accurately bid the highest amount of money you are willing to pay for the product.

Example 1:
Suppose the highest amount of money you are willing to pay for the product is $10, so you bid $10. Suppose this product is randomly selected at the end of the study.
Possible Outcomes:
If the randomly drawn price is $5, then you will receive the product and pay $5 – because your bid was higher than the random price. The $5 will be deducted from your balance of $15, so you will receive the product and $10 ($15-$5).
If the randomly drawn price is $10, then you will receive the product and pay $10 – because your bid was equal to the random price. The $10 will be deducted from your balance of $15, so you will receive the product and $5 ($15-$10).

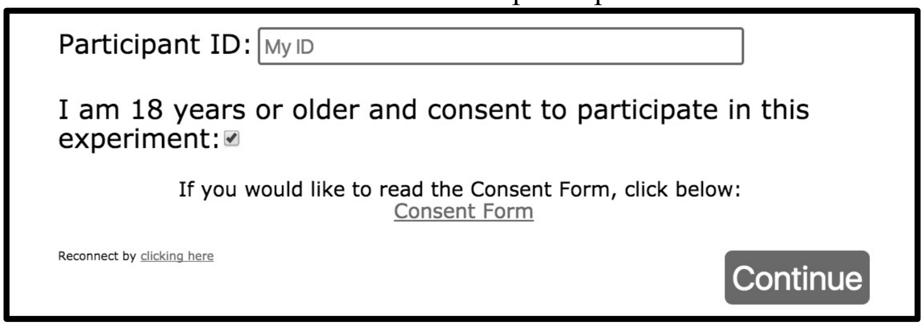
If the randomly drawn price is $12, then you will not receive the product because your bid was lower than the random price. You will receive $15 and no product.

Example 2:
Say that the highest amount of money you are willing to pay for the product is $15, so you bid $15.
Possible Outcomes:
If you bid $15 you will definitely receive the product because any random price will be equal to or less than $15, for example:
If the randomly drawn price is $15, then you will receive the product and pay $15 – because your bid was equal to the random price. The $15 will be deducted from your balance of $15, so you receive the product and $0 ($15-$15).
If the randomly drawn price is $2, then you will receive the product and pay $2 – because your bid was higher than the random price. The $2 will be deducted from your balance of $15, so you receive the product and $13 ($15-$2).

Example 3:
Say that the highest amount of money you are willing to pay for the product is $0, so you bid $0.
Possible Outcomes:
If you bid $0 you will either receive the product for free ($0) and still receive $15, or you will not receive the product and receive $15, for example:
If the randomly drawn price is $0, then you will receive the product and pay $0 – because your bid was equal to the random price. The $0 will be deducted from your balance of $15, so you receive the product and $15 ($15-$0).
If the randomly drawn price is $2, then you will not receive the product and will be paid $15 – because your bid was lower than the random price.

Appendix D Experiment order

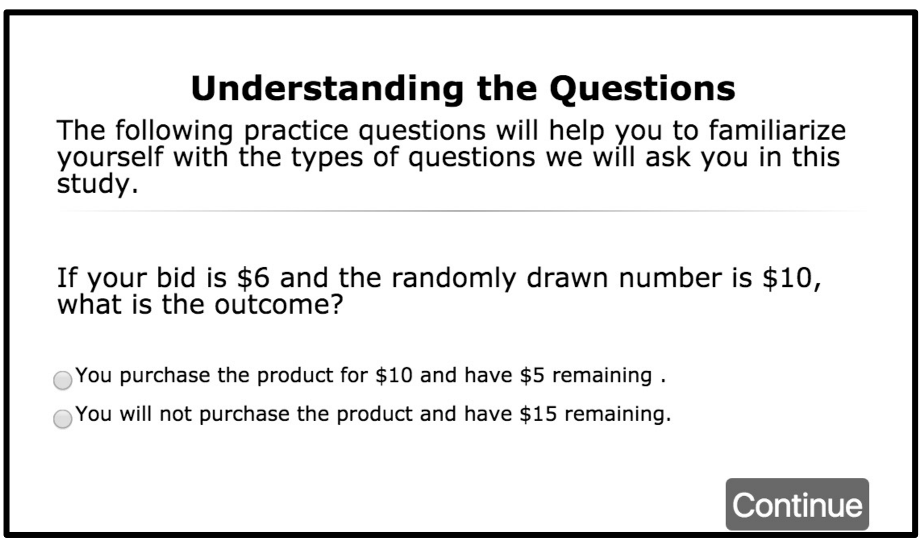
The following screen images show the order of the experiment as it was presented to participants on the tablets. The first screen shown to participants was:



Participants were assigned a unique Participant ID.

The next screen displayed the experimental instructions and examples, which participants scrolled through (shown in Appendix C).

Next, participants completed five training questions. All questions were the same for each participant and they were presented in the same order for each individual.



Once participants selected their answer and pressed ‘Continue’, they were informed if they had answered correctly or incorrectly.

Understanding the Questions

The following practice questions will help you to familiarize yourself with the types of questions we will ask you in this study.

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

- (selected) You purchase the product for $10 and have $5 remaining .
- You will not purchase the product and have $15 remaining.

Your answer is incorrect. Please try another practice question.

Next

If your bid is $8 and the randomly drawn number is $8, what is the outcome? what is the outcome?

- (selected) You purchase the product for $8 and have $7 remaining.
- You will not purchase the product and have $15 remaining.

Continue

If your bid is $8 and the randomly drawn number is $8, what is the outcome? what is the outcome?

- (selected) You purchase the product for $8 and have $7 remaining.
- You will not purchase the product and have $15 remaining.

Your answer is correct. Please try another practice question.

Next

If your bid is $4 and the randomly drawn number is $1, what is the outcome?

- You purchase the product for $1 and have $14 remaining.
- You will not purchase the product and have $15 remaining.

Continue

If your bid is $4 and the randomly drawn number is $1, what is the outcome?

- (selected) You purchase the product for $1 and have $14 remaining.
- You will not purchase the product and have $15 remaining.

Your answer is correct. Please try another practice question.

Next

If your bid is $9 and the randomly drawn number is $5, what is the outcome?

- You will purchase the product for $9 and have $6 remaining.
- You will purchase the product for $5 and have $10 remaining.

Continue

If your bid is $9 and the randomly drawn number is $5, what is the outcome?

- You will purchase the product for $9 and have $6 remaining.
- (selected) You will purchase the product for $5 and have $10 remaining.

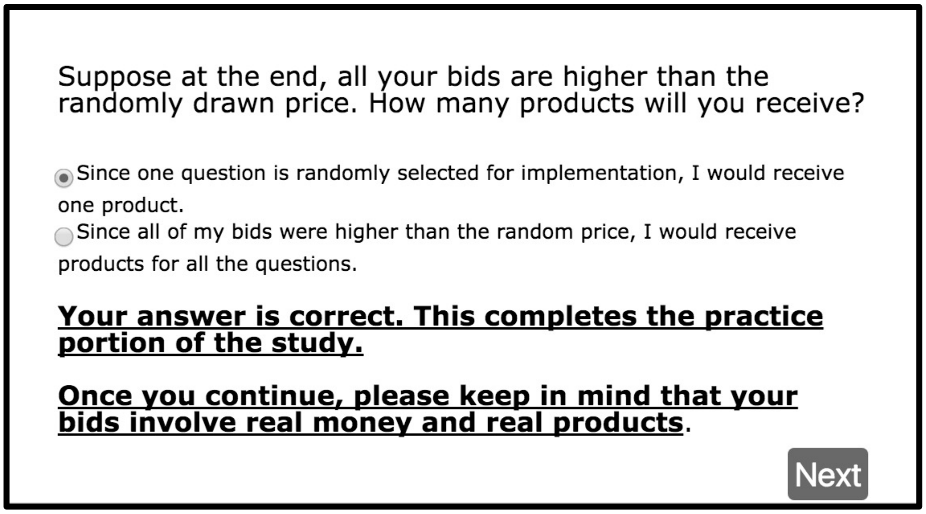
Your answer is correct. Please try another practice question.

Next

Suppose at the end, all your bids are higher than the randomly drawn price. How many products will you receive?

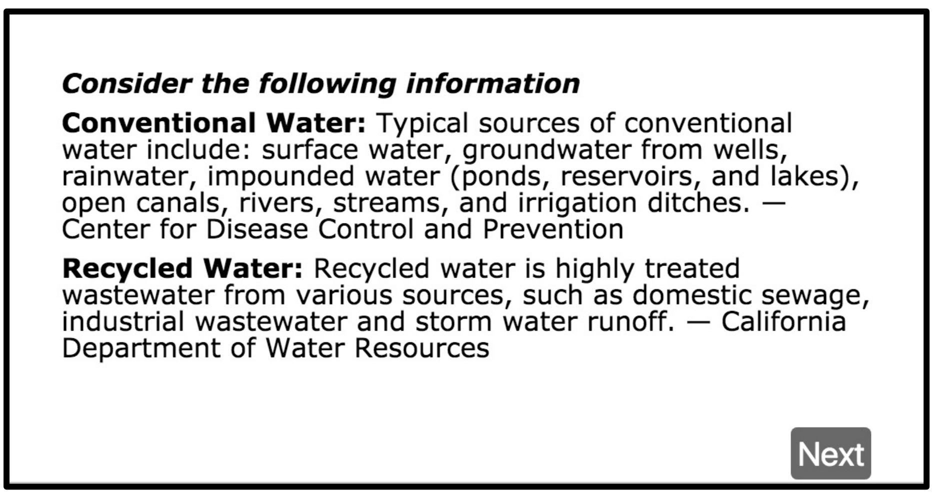
- Since one question is randomly selected for implementation, I would receive one product.
- Since all of my bids were higher than the random price, I would receive products for all the questions.

Continue



Participants were reminded of the non-hypothetical nature of the real experiment and the implications of their choices.

The next screen displayed definitions of conventional and recycled water.



Following the definitions, the treatment information was displayed (outlined in Appendix B).

After the treatment information, participants were asked to place bids on the six different products. The products were displayed in random order; an example is shown below. All products and bids were contained on one screen that participants scrolled through. Note that pictures were shown in colour during the experiment.

1 lb. of strawberries

What is the highest amount of money you are willing to pay for these strawberries?

- USD Bid: **$** +

1 lb. of strawberries that were produced by a company whose farms use **recycled** water on their fields

What is the highest amount of money you are willing to pay for these strawberries?

- USD Bid: **$** +

A 100% cotton, white t-shirt that was produced by a company whose farms use **conventional** water on their fields

What is the highest amount of money you are willing to pay for this t-shirt?

T-shirts in all sizes are available (S-XL).

- USD Bid: **$** +

A 100% cotton, white t-shirt

What is the highest amount of money you are willing to pay for this t-shirt?

T-shirts in all sizes are available (S-XL).

- USD Bid: **$** +

1 lb. of strawberries that were produced by a company whose farms use **conventional** water on their fields

What is the highest amount of money you are willing to pay for these strawberries?

- USD Bid: **$** +

A 100% cotton, white t-shirt that was produced by a company whose farms use **recycled** water on their fields

What is the highest amount of money you are willing to pay for this t-shirt?

T-shirts in all sizes are available (S-XL).

- USD Bid: **$** +

After placing bids on each product, participants were directed to a new screen, which contained the survey questions (as listed in Appendix E).

Once participants had finished and submitted the survey, the last screen of the experiment was shown. The last screen showed the result of the random product selected and the outcome of the bid comparison to the random number, as shown in the example below.

> a 100% cotton, white t-shirt was randomly chosen. The price for this item is $12.55. You bid $7.51. Since your bid is lower than the price you have not purchased the item. **You will receive $15**.
>
> Thank you for participating! Please return this tablet.

Appendix E Survey questions

Please answer the following questions:
(1) What is your age?

(2) What is your gender?
Male
Female
Other (please specify)

(3) What is your profession?
Government
Education
Business
Agriculture
Healthcare
Student
Other (please specify)

(4) Are you:
Politically liberal
Politically moderate
Politically conservative
Other (please specify)

(5) Which category best describes your household income (before taxes) in 2016?
Less than $10,000
$10,000-$14,999
$15,000-$24,999
$25,000-$34,999
$35,000-$49,999
$50,000-$74,999
$75,000-$99,999
$100,000-$149,999
$150,000-$199,999
$200,000-$249,999
$250,000 and above

(6) What is the highest level of education that you have completed?
Grade school
Some high school
High school graduate
Some college credit
Associate degree
Bachelor's degree
Graduate degree/Professional

(7) Do you have a child/children under the age of 18 years old in your household?
Yes
No

(8) How often do you consume fruit?
__times per month

(9) Are you the primary shopper in your household?
Yes
No

(10) Do you think millennials (individuals born between 1981 and 1997) are more likely to prefer using recycled water for crop irrigation?
Yes
No
Not sure

(11) Do you think individuals in your community are more likely to prefer using recycled water for crop irrigation?
Yes
No
Not sure

(12) Do you think the majority of consumers prefer using recycled water for crop irrigation?
Yes
No
Not sure

(13) Did you know that social norms (what most people do) can influence our decisions?
Yes
No
Not sure

(14) What is the percentage of organic foods in your overall vegetable and fruit consumption?
Non-Organic (0%) – *slider* – Organic (100%)

(15) Do you grow your own food?
Yes
No

(16) Which do you prefer?
Local Food
Non-Local Food
Do not care

(17) What type of water do you typically drink?
Bottled Water
Tap Water
Filtered Water
Other (please specify)

(18) Are you concerned about water availability in these areas?
Your Community
Yes
No
Your State
Yes
No
United States
Yes
No
Worldwide
Yes
No

(19) How concerned are you about climate change in these areas?
Your Community:
Not At All (1) – *slider* – Very Concerned (5)
Your State:
Not At All (1) – *slider* – Very Concerned (5)
United States:
Not At All (1) – *slider* – Very Concerned (5)
Worldwide:
Not At All (1) – *slider* – Very Concerned (5)

(20) Do you prefer conventional water or recycled water for use in food crop production?
Conventional
Recycled water
Do not care

(21) Do you prefer conventional water or recycled water for use in non-food crop production?
Conventional
Recycled water
Do not care

(22) How much do you trust information from the following sources:
Newspaper:
Strongly Disagree (1) – *slider* – Strongly Agree (5)
Government:
Strongly Disagree (1) – *slider* – Strongly Agree (5)
Non-profit organization:
Strongly Disagree (1) – *slider* – Strongly Agree (5)
Science:
Strongly Disagree (1) – *slider* – Strongly Agree (5)

(23) Do you prefer clothing made from organic cotton?
Yes
No
Do not care

(24) Do you educate yourself about how your clothing is produced?
Yes
No

Appendix F Power and sample size analysis

Note: The figure below was created ex-post to identify power given different sample sizes. Ideally, this type of analysis should have occurred prior to data collection. Nonetheless, it provides valuable information, not only for this study but also for future research that will depend on identifying sufficient power for the obtained effect. Here, we considered the mean of the control group (μ_1=3.8, this was the actual mean of the control group in our data set) as the starting point and graph power as a function of sample size, given an alpha value of 0.1. The resulting curves identify the appropriate sample size for identifying an effect (the difference between treatment and control group). For example, the figure below shows that a sample size (N=control + treatment group) of about 50 participants is sufficient to achieve 80% power (μ_2=4.5). The largest treatment group mean (newspaper messenger treatment) was 4.7.

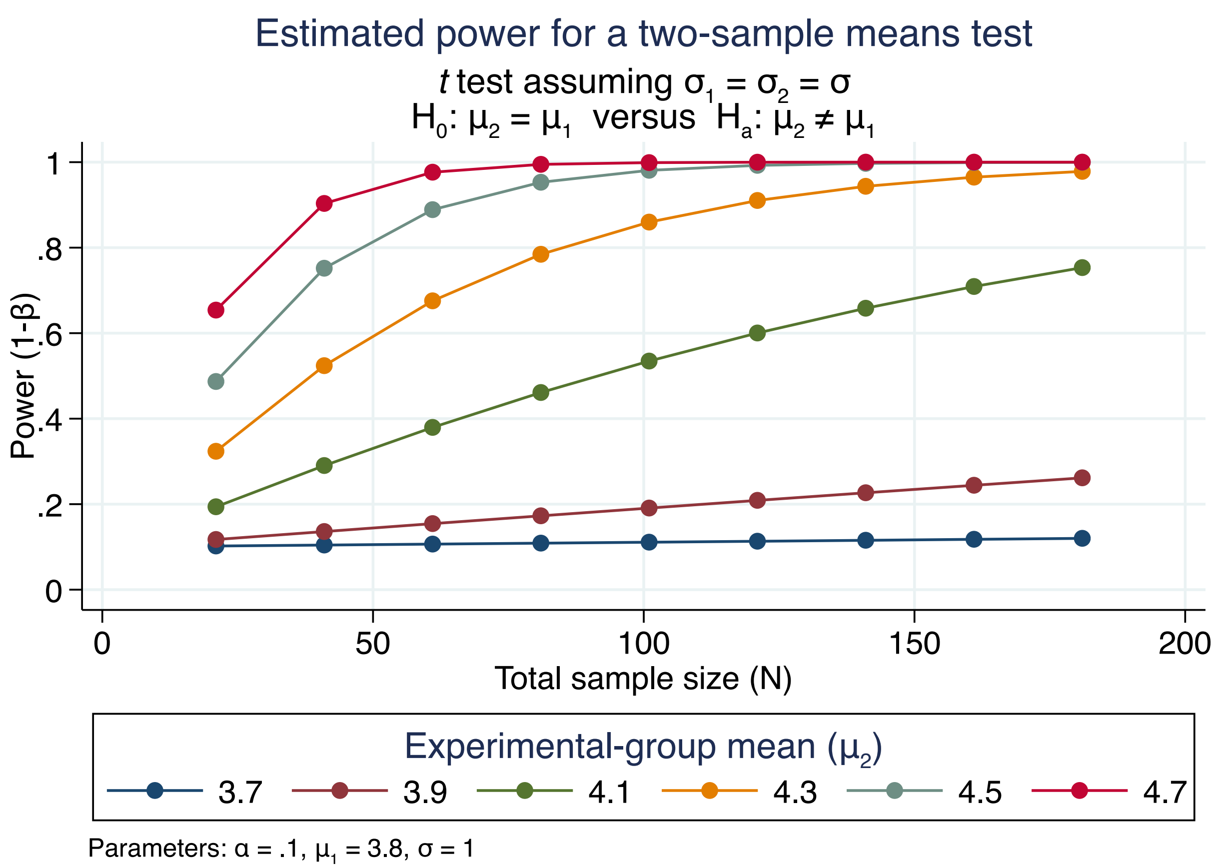


Figure A10: Ex post two means power and sample size analysis.

Appendix G Balance across treatments

Although participants were randomly assigned to treatment groups, it is important to analyze the balance of demographic characteristics across treatments (Table A1). 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=0.1225; Figure A12). We find that there are significant differences across treatments for both age (p-value=0.0050; Figure A13) and political affiliation (p-value=0.0006; Figure A14). However, due to the fact that these experiments were carried out as field experiments, it is difficult and often times impossible to ensure perfect balance across treatments. Here, laboratory experiments offer an advantage as balance can more readily be achieved given the additional control and access to computer programs that can account for these potential issues.

Table A1: The following table includes individual characteristics from the survey results split by treatment to demonstrate the balance across treatments. These results are also displayed graphically in the charts below.

			Political Affiliation (Percent)			
Treatment	Gender (Percent Female)	Age (Mean)	Liberal	Moderate	Conservative	Other
Newspaper	56.5	41.2	32.6	45.7	17.4	4.4
Scientific Study	61.5	46.7	38.5	33.3	18.0	10.3
Government organization	55.0	42.4	25.0	35.0	30.0	10.0
Non-profit organization	62.5	42.8	30.0	37.5	17.5	15.0
No information	65.6	45.8	25.8	51.6	16.1	6.5

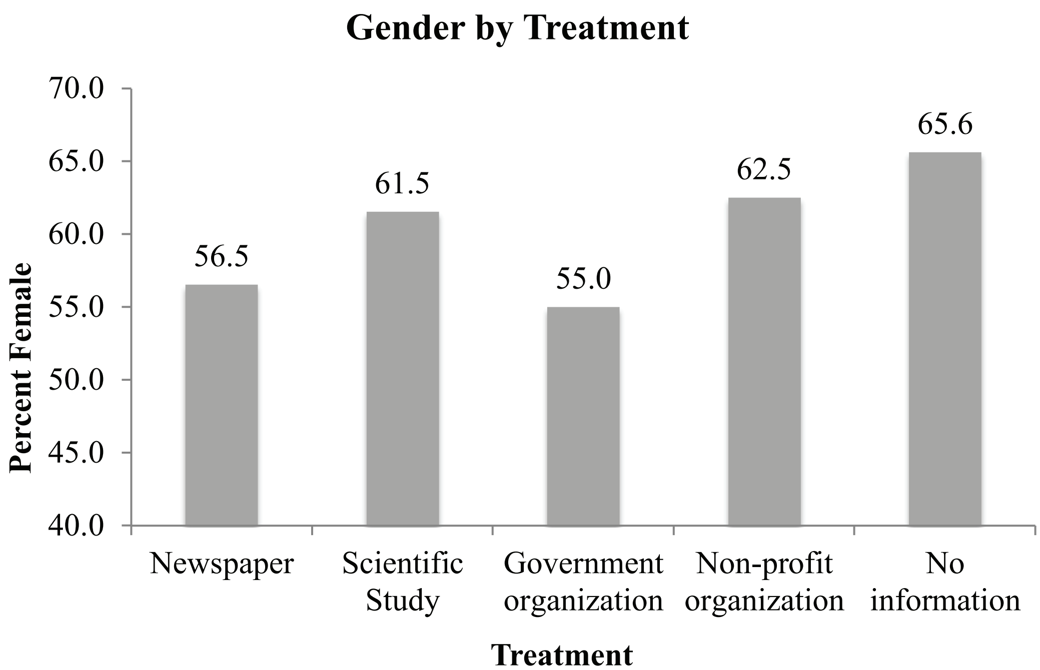


Figure A11: Percentage of respondents who identified themselves as females in the survey listed by treatment.

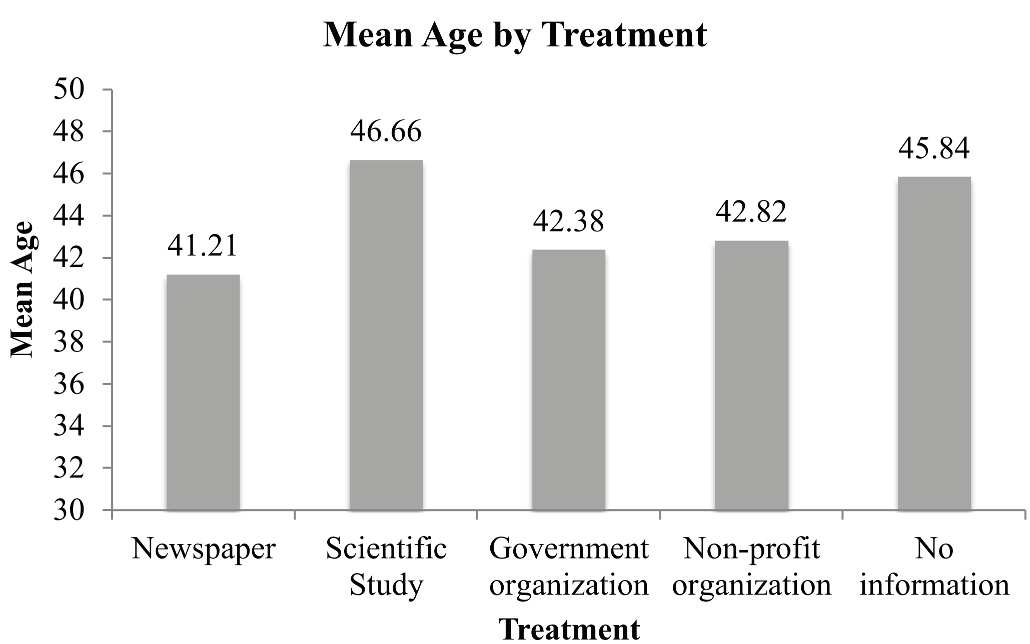


Figure A12: Mean age of respondents in each treatment.

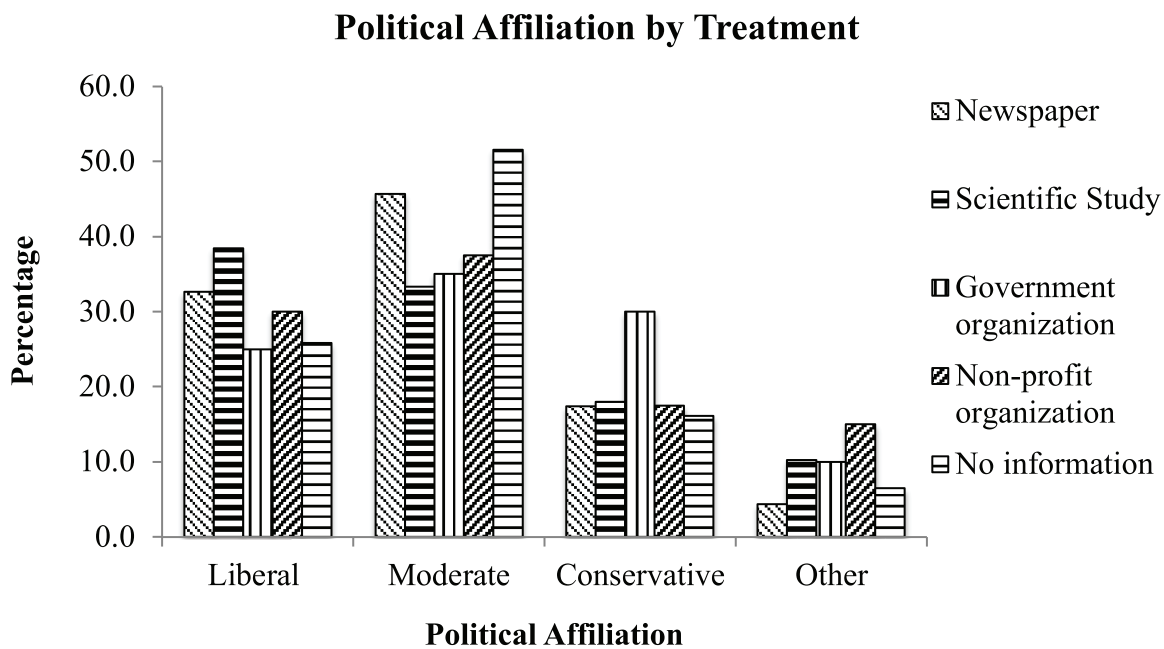


Figure A13: Balance of political affiliation among treatments shown by percentages of respondents grouped by political affiliation and separated by treatments.