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Research article

Recycled or reclaimed? The effect of terminology on water reuse perceptions

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ABSTRACT

Successful water recycling initiatives depend on public acceptance. In this study, we compared risk percpetions of water labeled as *recycled* or *reclaimed.*We recruited 1264 subjects in an online panel (Qualtrics) and randomly assigned them either treatment (*recycled* or reclaimed) water and asked about the contents and perceived risk. Participants in the *reclaimed* condition were more likely to perceive the water to have harmful ingredients compared to the *recycled* condition. The odds of direct use acceptance for those in the *recycled* condition are 1.41 times (or 41%) more likely than those in the *reclaimed* condition. Similar results were found for indirect uses. A major finding of this study is that terminology influences the perceived contaminants and risk of reused water. Prior studies have found strong evidence that the way reused water is communicated can influence public perception. Policy impilcations favor the use of recycled water, likely due to the positive connotation recycling has in the U.S. today..

1. Introduction

The global water crisis has resulted in high demand for water and an urgency to ensure its security (United Nations, 2019). Growing populations and morphing ecosystems, influenced by modern agricultural techniques and climate change, have made water quality and quantity issues salient within the scientific and political spheres (Vörösmarty et al., 2010). Water recycling, the process in which wastewater is treated for reuse in agricultural, industrial, natural, and residential systems, has been proposed to alleviate some of this water burden (US EPA, 2012).

Despite technological advancements that have vastly improved wastewater treatment processes in quality and cost, the public remains largely skeptical of its use and integration within public and private water systems (Buyukkamci and Alkan, 2013; Dolnicar and Hurlimann, 2010; DuBose, 2009). Among potential factors influencing public acceptance, none have garnered as much attention as the “yuck factor” or the disgust at potential harmful contaminants in the water (Furlong et al., 2019). In response, campaigns have been initiated to reduce the perception that reused water is unsafe with the goal of garnering acceptance for relevant legislation. These campaigns have been most prominent in regions with persistent droughts such as Australia; nonetheless, many countries, including the United States, consider water reuse an increasingly pressing issue.

A wide breadth of terminology is used to describe the water recycling process and previous research has found specific terms to have significant impact on how it is perceived (Fielding et al., 2015, 2019; Furlong et al., 2019; Menegaki et al., 2009). While the water source and treatment process are sometimes used to technically define the reused water, umbrella terms of *recycled* and *reclaimed* are often used when communicating to the public. These terms are synonymous and do not allude to a particular treatment or source but to the general water product. Thus, any reused water is typically labeled as *recycled* or *reclaimed.* The majority of existing research individually compares *recycled* or *reclaimed* with other specific (e.g., tertiary-treated) and media-utilized (e.g., toilet-to-tap) terms. Little work has tested the influence of *recycled* and *reclaimed*, two synonymous terms, against one another. More so, scant work has explored why certain water recycling terms are preferred beyond sociodemographic differences (Rock et al., 2012). Thus, this study attempts to expand the psychological explanations for why different terms elicit more or less perceived risk, and ultimately more or less acceptance. The results aim to provide decision-makers and communicators with further understanding of the mechanisms behind different terminology preferences in order to better craft policy and marketing efforts.

2. Literature review

The use of water recycling within the United States has grown exponentially in the past decade with more treatment systems and facilities being implemented. Currently, the bulk of facilities are for non-

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potable reuse (e.g., landscape irrigation), however recent initiatives have sought to establish more direct human applications of the water, such as for drinking (WateReuse, 2015). The level of treatment administered on the water varies depending on its intended use and local safety standards (US EPA, 2012). For instance, water repurposed for food crop irrigation, a more direct human application, may need microfiltration, chemical coagulation, and disinfection to remove harmful contaminants; whereas, reused water intended for non-food crop irrigation may only need to go through biological oxidation and disinfection.

While water recycling has many economic and environmental benefits (Toze, 2006), its success is reliant upon public support. Throughout the years, socio-psychological barriers such as the yuck factor and chemophobia have hindered public acceptance despite reused water's minimal health and environmental risks (Fielding et al., 2019; Furlong et al., 2019; Wester et al., 2016). Broadly referring to the instinctive concern regarding novel or unfamiliar science technologies, the yuck factor has manifested as a fear of reused water containing human feces (Leong, 2010; Schmidt, 2008). Mass media have perpetuated the yuck factor by describing the water as "toilet-to-tap" and "recycled sewage" (Po et al., 2003). Additionally, chemophobia, an automatic aversion to chemicals, has negatively influenced consumers' willingness to use reused water based on a fear of chemical pollutants (de França Doria, 2010).

In consequence, the public generally perceives reused water as risky, particularly for applications bringing it into close contact with humans, i.e., direct uses (Fielding et al., 2015; Hurlimann, 2007; Ross et al., 2014). While drinking may be viewed as the most direct use, other direct applications exist such as bathing and cooking. Regardless of the specific application, it is important to note that prior studies have found consumers to differentiate between direct and indirect (e.g., replenishment of toilets) uses when assessing the risk of the water, with greater risk assigned to the former (Redman et al., 2019; Hurlimann and Dolnicar, 2016). In assessing the risk, consumers often view the potential health risk to overpower any economic or environmental benefit that water recycling may bring. Indeed, in an attempt to model the decision-making process, Nancarrow et al. (2008) found health risk to be the only form of risk (i.e., environmental and system) to negatively correlate with behavioral willingness to use reused water.

To better understand and potentially reduce the perceived risk of reused water, scholars have tested the effect of how reused water is communicated (Fielding et al., 2015; Goodwin et al., 2018). Of particular relevance, terminology has been demonstrated to influence public support of environmental issues by framing the way people view them (e.g., Campbell et al., 2015). For example, climate change research has shown *global warming* and *climate change* to produce significantly different perceptions by influencing the issue's attributed cause (i.e., human vs. natural: Schuldt et al., 2011).

For reused water, research has generally found terms specific to the water source or process to be more accepted than general terminology. Marks et al. (2008) found Australian respondents to be more hesitant to use *reclaimed* or *recycled* water for household uses than *stormwater*, *seawater*, or *rainwater.* Likewise, *recycled* water was least preferred for drinking compared to *greywater* and *stormwater* water (Fielding et al., 2015). Yet, in studies comparing *recycled* or *reclaimed* to terms referencing the waste aspect of the water (e.g., *treated wastewater*), the umbrella terms have been most preferred (Menegaki et al., 2009). Thus, it appears that perceptions of *recycled* and *reclaimed water* are contingent upon whether people view it to be more or less associated to waste when compared to other terminology (Furlong et al., 2019). Little research, however, has directly compared *recycled* and *reclaimed* against one another despite their prolific usage in research, the media, and policy. Rather, as has been previously mentioned, studies often compared one (*recycled* or *reclaimed*) to a different technical or media-utilized term. Although *recycled* is most commonly used internationally, recent initiatives in Texas, California, and Florida use *reclaimed* (US EPA, 2012), calling into question whether these terms are perceived differently by the general public.

Extant literature in risk perceptions has shown familiarity to be a significant predictor of risk: people assign more risk to what is unknown and less risk to what is familiar (Song and Schwarz, 2009). Though *reclaimed* is predominately used to describe treated wastewater, the term *recycle* has a longer history in the US and used within a variety of contexts. It is then assumed that *recycled* is a more familiar term to the general public. Additionally, the US recycling rate has been steadily growing due to increased advocacy and promotions (US EPA, 2017), potentially associating the word *recycle* with positive environmental connotations and, ultimately, favorable perceptions. In consideration of this logic, it could then be expected for reused water labeled as *recycled* to be perceived as less risky than when labeled as *reclaimed.*

This study goes beyond demographic differences to understand term preference by testing the potential psychological mechanisms at play. Humans are limited in the amount of cognitive effort able to be expended at a given time, forcing people to employ heuristics, or mental shortcuts of beliefs, to lessen the resources needed to make decisions (Chaiken, 1980; Kleinmuntz, 1985). Within this decision-making perspective, the yuck factor and chemophobia can be seen as the reinforcement of the contagion heuristic, the belief that "once in contact, always in contact" (Rozin et al., 2015, pg. 51), or more applicable to reused water, "once contaminated, always contaminated." Thus, even if the reused water has undergone filtration and treatment, those utilizing the contagion heuristic will perceive the water to be risky due to its previous contact with harmful substances. The relationship between the contagion heuristic effect and terminology can then be understood as whether certain terms activate negative associations of reused water (e.g., waste). Because this proposed relationship has yet to be tested, this study examines whether water termed as *recycled* will be more preferred due to being automatically perceived with less negative associations and harmful contaminants than *reclaimed.*

When considering influence factors, profiles of reused water acceptors have mostly been limited to sociodemographic information. For instance, there are consistent findings that strong accepters tend to be male, older, and highly educated (Dolnicar and Schäfer, 2009; Gu et al., 2015). However, within an investigation of terminology, the cognitive factor and motivational impact of expertise and involvement are also of concern. Expertise refers to a person's knowledge, skill, or training on a topic, whereas involvement pertains to the person's assigned importance or relevance of the issue (Behe et al., 2018; Hoffman, 1998; Todorov et al., 2002). Although theoretically distinct, expertise and involvement have been found to be highly correlated (Behe et al., 2018).

Much research has examined the impact of cognitive influence and has generally found a positive relationship between knowledge and acceptance of reused water (Dishman et al., 1989; Dolnicar et al., 2011; Hurlimann, 2007; Hurlimann et al., 2008). Yet, the kind of knowledge tested varies, such as knowledge regarding the actual water reuse system (Hurlimann, 2007), the agency initiating the proposal (Dolnicar et al., 2011), and the general water recycling process (Dishman et al., 1989). Less research has explored the motivational factors underlying reused water acceptance, and of those that have, the majority have tested the role of environmental concern with mixed results. For example, Dolnicar et al. (2011) found environmental concern to positively influence acceptance. Conversely, Hurlimann et al. (2008) found no relationship between environmental concern and acceptance.

To address some of the inconsistencies found in motivational influence and to introduce a more universal point of knowledge to predict water recycling acceptance, this study measured self-reported water conservation expertise and involvement. The topic of water conservation, which encompasses the larger problem of droughts and the specific actions attempting to alleviate this burden, has not been investigated in the water recycling literature but may provide a more distinct point of reference for cognitive and motivational influences. A majority of Americans may not be knowledgeable about water recycling. Thus, targeting water conservation may be more predictive of willingness to use than knowledge of specific water recycling processes, which may be too niche, or environmental concern, which may be too broad. Thus, we predict that water conservation expertise and involvement, and perceived risk, will predict the public's willingness to use the water. Specifically, while greater risk will negatively predict willingness to use, greater expertise and involvement should positively affect reported willingness.

This study then has three primary goals. First, to test whether water labeled as *recycled* or *reclaimed* is perceived with more or less risk. Second, to conduct a more explicit test of the contagion heuristic to determine whether differing risk perceptions of the terms may be further explained by the automatic associations assigned to them. Lastly, to examine the extent to which willingness to use reused water for direct and indirect applications can be explained by the factors of water conservation expertise and involvement, terminology, risk perceptions, and demographic data.

3. Materials and methods

3.1. Participants and procedure

Participants ($N = 1264$) were recruited through an online participant pool of US residents (Qualtrics) during the fall of 2017. Participants were an average age of 45.37 years ($SD = 16.25$; range 17–88) and mostly female (72.3%). For race/ethnicity, participants identified as white/Caucasian (83.3%), black/African American (8.1%), Hispanic/Latino (5.7%), and Asian (3.9%).[1] Participants were fairly well educated, with 40% having a bachelor's degree or higher. The average household income of participants was $70,000. Residents from all 50 states and the federal district of Washington, DC, were represented in the sample, with California representing the highest percentage of participants (9%).

After providing informed consent, participants were asked to indicate their current water source and provide a safety rating (data not analyzed here). Participants were then randomly assigned to view questions that consistently described the water as either *recycled* ($n = 631$) or *reclaimed* ($n = 633$). Participants were not provided a definition but were intended to infer their own. Participants then answered items regarding their automatic associations, perceived contaminants of the water, perceived risk, willingness to use, and water conservation expertise and involvement. Later, participants were exposed to one of three different priming messages regarding the source of the reused water and re-reported perceived risk and willingness to use; however, these data were part of a larger experiment not analyzed here. Four standard distraction checks (e.g., "please choose option 'B'") were included within the questionnaire to ensure active and engaged participation. Only those who passed all distraction checks were included.

3.2. Measures

Participants' automatic associations of reused water were assessed using two measures. First, participants were asked to describe in an open-field response what they believed to be in *recycled/reclaimed* water. Participants were then asked to indicate what items they believed to be in the water from a list of 23 options (0 = *no,* 1 = *yes*). The option list included both positive (e.g., vitamins) and negative (e.g., human waste) items.

To measure perceived risk and willingness to use, participants were presented with eight different common uses of reused water, including three direct (drinking, showering/bathing, and cooking) and five indirect (watering the lawn, firefighting, flushing the toilet, washing the car, and watering public parks) applications. The categorization of these specific uses is based on prior literature finding that consumption and/or direct skin contact with the water to be differentially perceived (Dolnicar and Schafer, 2009; Dolnicar and Hurlimann, 2010; DuBose, 2009; Gu et al., 2015; Hui and Cain, 2017). For perceived risk, participants indicated the extent to which they thought using *recycled/reclaimed* water for each purpose would be extremely risky (−2) to extremely safe (2). We scaled the risk items to create separate measures of perceived risk for direct (Cronbach's $\alpha = 0.903$) and indirect (Cronbach's $\alpha = 0.939$) uses. A comparison of means yielded a significant difference between groups for perceived risk of direct and indirect uses, supporting that risk perceptions differ depending on the intended use of the water, $F(12, 1263) = 29.18$, $p \leq .001$. On average, direct uses were largely seen as riskier ($M = -0.25$, $SD = 1.01$) than indirect uses ($M = 0.91$, $SD = 0.85$). For willingness to use, participants indicated their acceptance to use *recycled/reclaimed* water (0 = *no,* 1 = *yes*) for each application.

Self-reported water conservation expertise and involvement items were collected using a scale developed by Behe et al. (2018). Expertise was measured on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*) regarding seven statements (e.g., "I consider myself knowledgeable about water conservation"). For water conservation involvement, participants responded to the statement "I think that water conservation is" using 5-point bipolar scales (e.g., "unimportant – important").

Lastly, a number of relevant socio-demographic variables were measured (Dolnicar and Schafer, 2009; Fielding et al., 2015). Specifically, age, gender, and education were collected. We additionally examined the influence of state residency, as those in water scarce states may be more concerned about water shortages (Fielding et al., 2015) or simply more aware of the issue. According to the US Drought Monitor (2019), 12 states are currently identified as abnormally dry for water (i.e., having water scarcity): Arizona, California, Colorado, Florida, Idaho, Nevada, New Mexico, North Dakota, Oregon, Texas, Utah, and Washington. Thus, participants were coded to be a water scarcity resident (=1) or not (=0).

Exact measure items can be found in the Supplementary Materials (Table A1).

3.3. Statistical and coding analyses

Statistical analyses were performed using SPSS Statistics, version 25.0. Descriptive statistics for all variables are displayed in Table 1. First, the experimental manipulation of terminology (*reclaimed* = 0, *recycled* = 1) on perceived risk were tested using two unpaired *t*-tests for indirect and direct uses. Open-ended responses gauging automatic associations were coded by two trained researchers to determine whether the responses were positive, negative, neutral, or unknown in valence toward *recycled/reclaimed* water. All disagreements were resolved through discussion. Chi-square tests were then performed to assess whether participants in the terminology conditions differed in their automatic associations (i.e., the coded responses), perceived contaminants of the water, and willingness to use. Lastly, factors influencing willingness to use the water were predicted using separate multivariate logistic regression analyses for direct and indirect uses. The outcome variables of direct and indirect willingness were constructed as two dichotomous items, indicating whether a participant reported being willing to use the water for at least one of the direct and indirect uses, respectively. Continuous predictors in the model included perceived risk of direct and indirect uses, self-reported water conservation expertise and conservation, and age. Categorical predictors included experimental exposure (0 = *reclaimed;* 1 = *recycled*), gender (0 = *female;* 1 = *male*), education (0 = *no 4-year college degree*; 1 = *4-year college degree or higher*), and water scarcity residency (0 = *no*, 1 = *yes*). An examination of the variance inflation factors (VIF) revealed no violations of multicollinearity (<2). The regression coefficients are report in logged form along with the standard error, yet data are described in the text using odds ratios; *p*-values less than 0.05 were considered statistically significant for two-sided testing.

[1] Participants were able to identify as more than one race, resulting in a sum total greater than 100%.

Table 1
Means, standard deviations, reliabilities and correlations between variables.

Variable	*M*	*SD*	α	1	2	3	4	5	6	7	8
1. *Recycled* terminology	–	–	–								
2. Perceived risk (direct)	−0.25	1.10	.90	.07*							
3. Perceived risk (indirect)	0.91	0.85	.94	.07**	.39***						
4. W.C. involvement*	4.13	0.69	.86	.02	.08***	.04					
5. W.C. expertise*	2.66	0.92	.93	.04	.10***	.03	.55***				
6. Age	45.37	16.25	–	-.09**	-.02	.17***	-.05*	-.04			
7. Male	0.28	.45	–	.02	.17***	.09**	.05*	.16***	.15***		
8. Education	3.83	1.49	–	-.02	.09***	.11***	.05*	.09**	.05*	.10***	
9. Water Scarcity Resident	.36	.48	–	-.02	-.05	.03	.07*	.13***	-.03	-.05*	.06*

Note: W.C. = water conservation; *$p = .05$, **$p = .01$, ***$p \leq .001$.

4. Results

4.1. Terminology influence on perceived risk

Compared to those in the *reclaimed* condition, participants answering toward *recycled* water had safer risk perceptions for both direct ($t(1,262) = -2.34$, $p = .019$) and indirect ($t(1,262) = -2.62$, $p = .009$) uses. Specifically, participants within the *recycled* condition reported risk ratings of −0.18 ($SD = 1.04$) and 0.97 ($SD = 0.84$) for direct and indirect uses respectively, whereas those in the *reclaimed* condition reported lower scores ($M_{direct} = -0.31$, $SD_{direct} = 0.98$; $M_{indirect} = 0.84$, $SD_{indirect} = 0.85$). However, the effect sizes for both direct ($d = 0.13$) and indirect ($d = 0.15$) are considered relatively small.

4.2. Perceived associations and contaminants

We excluded 329 responses for simply reiterating the terminology of the water ("reclaimed," "recycled," or "reused") and 24 responses for being irrelevant. Thus, a total of 911 (71%) of the original 1284 responses were analyzed.

The frequencies for each valence category by terminology condition are shown in Fig. 1. A chi-square test showed a difference between association valence and condition: $\chi^2(3) = 18.13$, $p \leq .001$. Of those with positive associations, 66.7% were in the *recycled* condition, whereas only 33.3% were in the *reclaimed* condition. Furthermore, those with negative associations were slightly more likely to be in the *reclaimed* condition (50.3%) than those in the *recycled* condition (49.7%). Neutral responses were more likely to be in the *recycled* condition (62.6%), and uncertain responses were most frequent in the *reclaimed* condition (52.1%). All comparisons were different at the $p \leq .05$ significance level. In sum, those in the *reclaimed* condition had less positive (92–56 respondents) yet more neutral (72–36 respondents) and uncertain (174–189 respondents) associations to reused water than those in the *recycled* condition.

To further test how participants perceived reused water by terminology condition, the reported potential contaminants in the water were analyzed (see Fig. 2). Participants in the *reclaimed* condition were more likely to perceive the water to have harmful bacteria, herbicides, pesticides, harmful chemicals, human waste, animal waste, insecticides, heavy metals, composted animal waste, dyes, hormones, and prescription drugs, than those in the *recycled* condition ($p \leq .05$). On the other hand, 18.4% of participants stated that *recycled* water contained nothing harmful versus 12.3% for *reclaimed* water: $\chi^2(1) = 8.93$, $p = .003$. Thus, participants generally viewed *reclaimed* water to have more harmful contaminants and *recycled* water to be more innocuous.

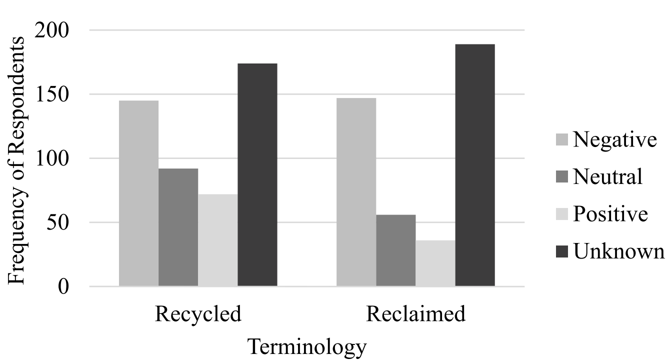

Fig. 1. Frequency of valanced association of contaminants in reused water based on terminology condition.

4.3. Predictors of willingness to use

Approximately one-quarter (25.7%) of all participants were willing to accept reused water for at least one type of indirect application: 17.1% reported acceptance of only one use, 4.7% for two, and 3.9% for all three. For indirect uses, 86.3% indicated acceptance for using reused water for at least one application: 16.1% reported acceptance for one use, 8.8% for two, 11.8% for three, 14.6% for four, and 35.0% for all five. Regarding the individual uses, greatest acceptance for reused water was for flushing the toilet (72.0%), followed by firefighting (61.6%), washing the car (60.5%), watering the lawn (58.7%), watering public parks (50%), bathing/showering (22.3%), cooking (9.8%), and lastly, drinking (6.1%).

Using chi-square analyses to examine the influence of terminology, we found labeling the water as *recycled* garnered greater acceptance for cooking ($\chi^2(1) = 9.26$, $p = .002$), drinking ($\chi^2(1) = 10.17$, $p = .001$), bathing/showering ($\chi^2(1) = 8.22$, $p = .004$), and flushing the toilet ($\chi^2(1) = 4.38$, $p = .036$). No significant differences were found for other uses.

In order to better predict willingness to use, we created two variables to represent whether participants were willing to use reused water for at least one direct (direct use acceptance) and at least one indirect (indirect use acceptance) purpose. As seen in Table 2, the expected relationship between terminology and willingness to use was found in the multivariate logistic regressions, controlling for the other model variables: the odds of direct use acceptance for those in the *recycled* condition are 1.41 times (or 41%) more likely than those in the *reclaimed* condition. Similar results present for indirect uses: those in the *recycled* condition are 1.60 times (or 60%) more likely than those in the *reclaimed* condition to be accepting of an indirect application of reused water. Regarding the direct use acceptance, increases in the perceptions of the water's safety for direct and indirect uses were associated with greater use willingness (198% and 24% increases, respectively). However, an unexpected finding occurred for indirect use acceptance: while greater perceived safety for indirect applications increased the odds of willingness to use, risk perceptions for direct uses had a negative relationship (i.e., a unit increase in perceived safety for direct uses decreased the odds by 50% of a person being willing to use the water for indirect usages). We deliberate on this finding more in the discussion.

Lastly, self-reported expertise of water conservation was not found to significantly predict willingness to use, however a positive relationship was found for involvement. Specifically, unit increases in water

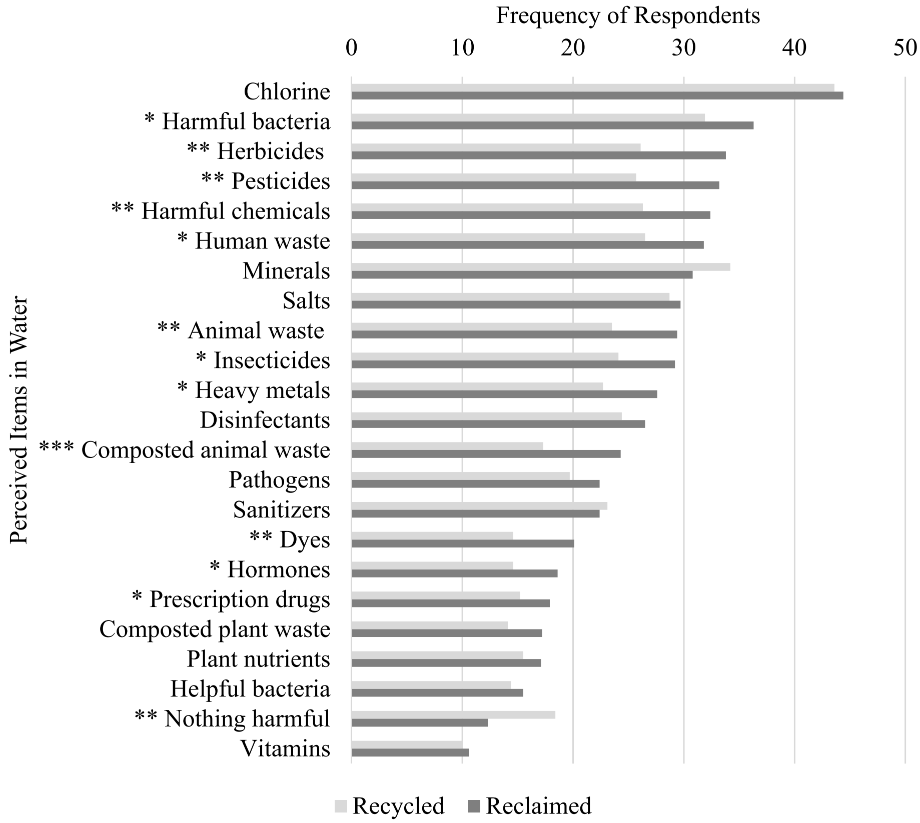

Fig. 2. Frequency of perceived contaminants based on condition. *p* values: * = 0.05, ** = 0.01, *** ≤ 0.001.

Table 2
Multivariate logistic regressions predicting willingness to use reused water for direct and indirect uses.

Predictors	Model 1: Direct uses			Model 2: Indirect uses		
	b (SE)	*Odds Ratios*	*p-value*	*b (SE)*	*Odds Ratios*	*p-value*
Terminology: *recycled*	0.34 (0.14)	1.41	.020	0.47 (0.17)	1.605	.008
Perceived risk (direct)	**1.09 (0.09)**	**2.98**	**≤ .001**	**−0.67 (0.11)**	**0.50**	**≤ .001**
Perceived risk (indirect)	**0.21 (0.11)**	**1.24**	**.049**	**1.11 (0.12)**	**3.04**	**≤ .001**
Expertise[a,b]	0.04 (0.10)	1.04	.668	−0.06 (0.11)	0.93	.576
Involvement[a,b]	**0.22 (0.10)**	**1.25**	**.036**	0.00 (0.12)	1.00	.989
Covariates						
Age[a]	−0.00 (0.00)	0.99	.631	0.00 (0.00)	1.00	.504
Male	0.58 (0.16)	1.79	≤ **.001**	−0.30 (0.19)	0.73	.114
No college degree	**−0.35 (0.15)**	**0.70**	**.023**	−0.19 (0.17)	0.82	.287
Water scarcity resident	−0.12 (0.16)	0.88	.431	−0.07 (0.18)	0.92	.671
Constant	−1.46 (0.17)	0.23	≤ **.001**	0.92 (0.17)	2.52	≤ **.001**
−2 Log Likelihood	1128.80			880.71		

[a] Variables are mean-centered.
[b] Refers to water conservation expertise and involvement.

conservation involvement were associated with a 25% increase in the odds of a person being willing to use reused water for direct applications.

5. Discussion

Water recycling has the potential to be an environmental and economical solution to the current water crisis by repurposing water from manufacturing, residential, and agricultural sources. Although considered safe by many local and national agencies, the public remains largely skeptical due to psychological barriers that reinforce the assumed risk of reused water such as the yuck factor. The purpose of this study was to test the effect of terminology on perceived contaminants, perceived risk, and willingness to use to better understand how people process information about water recycling.

A major finding of this study is that terminology influences the perceived contaminants and risk of reused water. Prior studies have found strong evidence that the way reused water is communicated can influence public perception; however, few have compared synonymous (vs. technical) terms. This distinction is vital as it allows us to better stipulate whether the semantic influence stems from automatic associations to the term. For instance, water source and treatment processes labeled with different technical terms may produce differences in perception, but it is unclear if this is due solely to terminology. Instead, the difference may be based on the actual difference in source or process. Although others found *recycled* to be the least effective term when garnering acceptance (e.g., Dolnicar and Hurlimann, 2010), the results of our association task indicate that compared to a less familiar yet synonymous term, *recycled* has more positive associations. When examining the effect of terminology, reused water termed as *reclaimed* had more negative risk perceptions and less odds of being accepted than when the water was described as *recycled.*

The results from this study provide initial support that the semantic effect of terminology regarding reused water stems from people's familiarity with the words. It can be safely assumed that the US public is familiar with the term *recycled* as many longstanding campaigns in a variety of areas have used it with much success (Waxman, 2016). The term *reclaimed,* on the other hand, has been less utilized in mass media initiatives. Thus it is potentially more susceptible to heuristics, such as the contagion heuristic, that are used in place of knowledge about the issue. Indeed, our results indicate *reclaimed* to be less understood than *recycled* water and perceived to have more negative contaminants. It then appears that while an unfamiliar technical term may encourage acceptance of reused water, as was found in other studies, an unfamiliar general term, such as *reclaimed*, is more susceptible to perceived risk. Thus, when confronted with a novel phenomenon, the familiarity with certain terms may mitigate any negative associations the yuck factor may produce toward reused water. Though we did not measure initial associations to an unfamiliar technical term (e.g., tertiary treated water) as the usage is not common in the US, this could be an avenue for future research to further understand how technical and general terms are perceived regarding reused water.

The results have strong practical implications as recent marketing campaigns have consistently used *reclaimed* within promotions. In the US, *recycled* and *reclaimed* are considered synonymous, and both are commonly used in campaigns and legislation. Notably, the usage of *reclaimed* appears to be more prevalent in southern and coastal states with current legislation in force. Our results suggest that this strategy may not be effective as it could increase initial wariness, especially as it pertains to toxic contaminants and health risks. Rather, campaigns may be more successful using more familiar terms, or may need to engage in additional preemptive work to make the public more aware of what *reclaimed* water means. Additionally, while large initiatives are being funded to rebrand reused water, such as by calling it "NEWater," our results suggest that utilizing a familiar term, such as recycled, may also be suitable for messages requiring immediate feedback, where there is little time for a new term to become familiar and well-received. However, it should be noted that the overall acceptance of reused water for direct uses was in most cases below 10% of the sample and therefore quite minimal. Thus, there is a clear need for continued work in how to encourage acceptance of direct uses of reused water.

A second key finding is the role of expertise and involvement with water conservation on willingness to use reused water. Previous studies have often investigated the role of knowledge in water reuse acceptance (Dishman et al., 1989; Dolnicar et al., 2011; Hurlimann et al., 2008), yet the object of measurement has varied from topics that are very broad to very precise. In an effort to find middle ground between the vastly different types of measurement, we tested the effect of water conservation expertise and involvement. Expertise refers to the more traditional aspects of knowledge, while involvement pertains to the motivational aspects of the issue, such as whether a person finds it interesting to learn about. It was then expected that willingness to use reused water would be positively predicted by expertise and involvement.

For direct use willingness, the direction of relationships was as expected. However, only involvement emerged as a statistical predictor. It is possible that since both expertise and involvement were measured using self-report measures, accurate reflections were not obtained. For example, a strong correlation was found between water conservation expertise and residency in a water scarce state (Table 1). It may be that our expertise measurement, in reality, captured exposure to the water conservation issue due to residency without tapping into actual knowledge. More direct assessments of water conservation expertise and involvement may help determine whether these factors truly predict reused water acceptance or are irrelevant.

For indirect use acceptance, the direction of effects for perceived risk was unexpected: greater indirect use acceptance was associated with greater perceived risk of the water for direct applications. To explain these findings, it is possible that participants engaged in some form of trade-off thinking: for those holding risky perceptions of the water for direct uses, the thought of using it for indirect applications may have seemed less severe or harmful. Thus, acceptance of recycled water for indirect uses came at the cost, or trade, of support for direct uses. Trade-off thinking has been observed in other forms of conservation (McShane et al., 2011), yet remains unclear in its practical application and benefit. This finding calls for a more nuanced understanding of how risk predicts reused water acceptance. Although the link between perceived risk and behavior has been well-documented in the literature (Brewer et al., 2004), the multi-dimensional perspective of water usage categories and potential trade-off decision-making may be impacting the risk-behavior relationship.

How reused water will be used evidently influences how it is perceived and what factors predict whether it is acceptable. It is possible that for indirect uses, self-reported involvement about water conservation may not be as important as when the intended use involves more direct human contact. More so, perceived risk of the water may only be impactful when the risk is isolated to a particular use. Future work may further investigate the conditions in which reused water is accepted, with particular attention on water conservation involvement and perceived risk toward specific uses.

6. Conclusion

Water recycling initiatives are contingent upon public acceptance. This study's findings stress the significance of semantics on reused water perceptions and underlie the importance of knowing pre-existing associations of general terms. More so, this study introduces the impact of involvement of water conservation on willingness to use. The research demonstrates the need for more understanding about the mechanisms guiding how reused water is perceived, particularly in a country that has less familiarity with and knowledge of water recycling processes and that refrains from technical jargon in promotional materials. We hope these findings encourage further work in reused water and provide guidance for those engaged in water recycling campaigns.

Author

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2020.110144.

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