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Comparing communication strategies for reducing residential water consumption

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A B S T R A C T

The current study tested the effectiveness of four different water conservation interventions drawn from the social psychological literature. 374 households in an affluent neighborhood in Los Angeles County were randomly assigned to receive one of four possible communications that either evoked social norms, social identity, personal identity, or the knowledge deficient approach (water saving tips). Each household's actual water consumption was measured at baseline (pre-intervention), in the short-term (1 week post intervention) and the long term (4 weeks post-intervention). The results of the study indicated that for high water consumers at baseline, the knowledge deficit approach resulted in a *more* water consumption than the other three conditions in the short term and long term. These results imply that the social norms, social identity, or personal identity approaches provided more promising avenues to encourage water conservation than the knowledge deficit approach. Implications of these results are discussed.

1. Comparing communication strategies for reducing residential water consumption

One of the most critical challenges facing our society is the rapid depletion of our fresh water resources. In particular, the Western United States currently faces significant challenges in meeting the water demands of its burgeoning population due to climate change, drought, and waste (Anderson & Woosley, 2005). For instance, the National Geographic reported that California is currently experiencing a mega drought, which could last up to 200 years (Kostigen, 2014). In early 2014, California Governor Brown declared a "drought emergency" and President Obama responded by visiting the state and pledging $183 million of federal funds to California for drought relief programs (Onishi & Davenport, 2014).

The water challenge in the West may be further exacerbated in the near future. The Third National Climate Assessment (2013) predicts that climate change will further decrease water supplies for cities and agriculture in the Western region while also increasing wildfires and sea levels. Scarcity of fresh water resources may be particularly debilitating for semi-arid Southern California, a region that has historically endured a number of water challenges and shortages (Ackerman & Stanton, 2011). In response, many cities in Los Angeles County are engaging in public outreach and education campaigns to encourage people to conserve water.

A common approach of outreach programs in the applied domain is to promote water conservation by informing individuals about water shortages and encouraging them to conserve water by outlining specific water saving tips (e.g., using low flow showerheads). This approach suggests that people have a disinclination to engage in pro-environmental behaviors because they have a *knowledge deficit* (e.g., Burgess, Harrison, & Filius, 1998; Schultz, 2002). Hence, if the knowledge deficit is remedied, individuals will be more likely to adopt sustainable attitudes and behaviors. Research has not provided encouraging results concerning the knowledge deficit-sustainable behavior link. In the realm of global climate change, studies suggest that achieving a better understanding of climate change does *not* translate into behavior change (Beattie, 2010; Finger, 1994; Leiserowitz, 2006; McKenzie-Mohr, 2008; Owens, 2000). Environmental knowledge may be a prerequisite for environmental behaviors, but not a sufficient condition (Pelletier, Tuson, Green-Demers, Noels, & Beaton, 1998). In fact, in some cases, Americans with a better understanding of global climate change are less likely to support and engage in environmental actions (Kellstedt, Zahran, & Vedlitz, 2008).

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Applied to water conservation, the knowledge deficit model would predict that individuals might not conserve water because they lack sufficient knowledge about water problems and may be unaware of steps that could be taken to avoid water waste. As such, informing individuals about water shortages and providing information about water saving tips should lead to water conservation. Research testing this idea has yielded mixed results (see Corral-Verdugo, Frías-Armenta, Tapia-Fonllem, & Frijo-Sing, 2012; Schultz, et al., in press; Moore, Murphy, & Watson, 1994). The key factor that may explain these mixed results may be whether water knowledge includes actual water saving skills. That is, it is important to know information about *why* protecting the environment is important and to develop necessary *skills* or knowledge about how to carry out a pro-environmental behavior (Corral-Verdugo, 2002). For instance, do individuals know how to plant drought resistant plants? Do they know how to reduce the frequency that their sprinklers water their lawns? Research suggests that water saving skills predict water conservation (Corral-Verdugo, 2002; Corral-Verdugo et al., 2012).

Extensive environmental educational efforts may be needed to make up for a knowledge deficit and to impart water saving skills. For instance, a series of water conservation lessons (Southwell, 2001), a persuasive film about water conservation (Kantola, Syme, & Nesdale, 1983), a 40-hour educational program (Fraijo, Corral-Verdugo, Tapia, & González, 2010), and a USAID environmental education program in Jordan (Middlestadt et al., 2001) positively influenced students' water attitudes and behaviors. While water education may influence behaviors, extensive environmental education programs to promote water conservation may not be realistic for a municipality to implement on a large public scale during a water crisis. During a crisis, a brief, mass communication intervention would be the most practical way to promote water conservation efforts. What type of communication strategy might be more effective for reducing water usage? To glean an answer to this question, the current study compared the effectiveness of the knowledge deficit approach (e.g., water saving tips) to three communication interventions drawn from the social psychological literature – social identity, personal identity, social norms – in reducing the water usage of affluent residential households in Southern California.

Our study only focused on an affluent neighborhood because affluent households employ much more water than non-affluent households (Corral-Verdugo, 2002; Corral-Verdugo et al., 2012). In a study in Phoenix, Arizona, which tracked affluent houses over 24 months, Harlan, Yabiku, Larsen, and Brazel (2009) found that the most important intervening variable between household income and water consumption was household size. The authors suggest that larger households consume more water because they tend to have more bathrooms, there is more surface area to clean, more plumbing that may be susceptible to leaks, and additional water consuming amenities such as swimming pools and fountains. Affluent households are also more likely to be engaged in the careless use of water and to be less cognizant of the water bill. Affluent individuals are more likely to live in newer homes, which have recently been found to be associated with higher water usage than older homes (Ruddell & Dixon, 2013). Overall, affluent households represent a vital population to target for water conservation efforts because affluence may be the most important factor in determining future natural resource conservation (Harlan et al., 2009).

2. Established interventions for water conservation

Given the importance of water conservation, there has been a surprising paucity of research examining different behavioral interventions that may promote water conservation in residential homes. Considerably more research attention has been paid to designing interventions for energy conservation and recycling than water conservation (Gregory & De Leo, 2003). Behavioral intervention studies on water conservation have focused on environmental educational interventions, behaviorist principles, or feedback (see Corral-Verdugo et al., 2012). Educational interventions concerning water have usually been a part of educational initiatives involving children in and out of the classroom. By and large, research suggests that these interventions are effective in influencing water usage behavior for children (Fraijo et al., 2010; Middlestadt et al., 2001; Southwell, 2001; Thompson, Coe, Klaver, & Dickson, 2011). However, the drawback of educational approaches is that they: (a) have not been widely tested on adult populations; and (b) may be expensive and time consuming to implement on a large-scale during a water crisis. Also, more affluent adults tend to be more educated than the poor, but they still consume more goods and services (Corral-Verdugo et al., 2012).

Water prices have also been found to play a role in water conservation (see Terrebone, 2005). Interventions that employ behaviorist principles have shown that positive reinforcement in the form of a jackpot (see Corral-Verdugo et al., 2012) and punishment (fines) can be effective in curbing water use (Agras, Jacobs, & Ledebeck, 1980). Additionally, charging higher fees for more water users (adjustable water rates) seems to reduce water usage compared to charging a flat water fee, particularly when resources are strained and people are weakly identified with a community (Van Vugt, 2001). These approaches are being adopted by some cities in Southern California and the Metropolitan Water District. However, increasing the cost of water may not be an effective water conservation strategy for affluent water users, who may view price increases as a negligible cost (Corral-Verdugo et al., 2012).

Arguably, the most research attention has been paid to providing feedback as a mechanism of promoting water conservation. Feedback provides residents with information concerning their individual water usage. Feedback is usually delivered via pamphlets or door hangers (e.g., Geller, Erickson, & Buttram, 1983; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007), but more recently, technological advances allow households to receive more extensive feedback with smart metering systems that can provide real-time water usage information (Schultz et al., in press). Data loggers can also be attached to household water meters to track water data every 10 seconds and provide households with detailed reports of the amount of water used per water fixture (Tom, Tauchus, Williams, & Tong, 2011). By and large, feedback interventions tend to reduce water usage. Geller, Winett, and Everett (1982) found that daily water usage feedback and a rebate decreased water usage by 30%. More recently, Tom and colleagues (2011) showed that 84% of households who received feedback from the data logger system reduced their water consumption. Other research suggests that combining feedback with other interventions is also effective. High consumers receiving dissonance and feedback or feedback alone significantly reduced their water consumption (Aitken, McMahon, Wearing, & Finlayson, 1994).

A variation of the feedback intervention paradigm provides households with normative feedback messages. These types of messages are rooted in *Focus Theory of Normative Conduct* (Cialdini, Kallgren, & Reno, 1991), which distinguishes between descriptive and injunctive social norms and outlines specific conditions under which each type of norm exerts the most influence on behavior. Descriptive norms describe how most people behave (only 20% of households recycle). Injunctive norms communicate social approval or disapproval by prescribing how individuals ought to act (100% of households should recycle). People are highly attuned to norms and they tend to act in accordance with them (Cialdini &

Trost, 1998). As such, communication that implicates social norms has to be carefully constructed to avoid unintended consequences such as inadvertently promoting more *unsustainable* behavior (Cialdini, 2003).

In a field experiment in San Marcos, California, Schultz and colleagues (2007) provided households with feedback regarding their own average daily energy usage along with either: (a) descriptive normative feedback concerning their neighborhood's average energy usage during the same time frame; or (b) descriptive normative feedback combined with injunctive normative feedback in the form of a happy face to communicate social approval if the household's energy usage was below the neighborhood mean or a sad face to portray social disapproval if the household's energy usage was above the neighborhood mean. Results showed that high consumers in the descriptive feedback condition decreased their energy consumption to be more on par with neighborhood norms. For low consumers, however, the same descriptive message actually had the unintended effect of increasing energy consumption. This boomerang effect probably occurred because consumers were influenced by descriptive feedback indicating that the average neighborhood energy usage was higher than their own. However, this effect was mitigated for low consumers when a descriptive message was combined with an injunctive one. That is, low consumers were less likely to boomerang when they learned that their rate of energy consumption relative to their neighbors' was met with social approval.

A recent field experiment replicated these findings in the realm of residential water consumption (Schultz et al., in press). Interestingly, this study also showed that individuals with a low sense of obligation to engage in water conservation were most influenced by a combination of descriptive and injunctive norms. The authors suggest that social norms may operate as a peripheral cue that provides residents with information about how much to consume. Individuals who perceive less obligation regarding water usage may not be as motivated to process information regarding water usage and water conservation, and thus may be more influenced by the behavior of others.

Affluent households may represent a population that has low personal norms to conserve water because the cost of water is affordable and water is a natural resource that facilitates water consuming affordances (e.g., swimming pools, large lawns, many bathrooms) that maintain an upper middle class lifestyle (Harlan et al., 2009). As such, peripheral cues such as descriptive and injunctive norms in the form of comparative feedback may be a more effective intervention for affluent households than providing households with water saving tips alone. The current study tests this possibility.

3. New approaches to conservation: personal and social identity

Norms may influence behavior to the extent that they help to make people feel good about their social identity (Christensen, Rothgerber, Wood, & Matz, 2004). Social identity is an individual's self-definition in terms of a group membership (e.g., Californian). The more people identify with a group, the more likely they are to align their behavior with the group's norms (Abrams & Hogg, 1990). Therefore, an alternate approach to promoting conservation is to communicate the idea that water conservation is normative of a particular social identity. *Social identity framing* (Seyranian, 2013, 2014; Seyranian & Bligh, 2008) may help toward that end. Social identity framing is a communication strategy that helps to link a social identity to a new behavior by stressing that this new behavior is a normative part of "who we are." This may be done, in part, through a communication process that uses a high level of inclusive language. Inclusive language helps to define and characterize a particular social identity. It is a rhetorical tool that contributes to the construction of a sense of "who we are" and "how we act." In this way, it relays which particular attitudes, values, or behaviors are normative for a group (Seyranian, 2013). Inclusive language entails language that alludes to *social identity* (we, us, them), *people* (e.g., society, nation) and *collectives* (e.g., civilization, community).

Several experimental studies have shown that a communication that frames social identity with high levels of inclusive language helps to promote positive proclivities toward pro-environmental initiatives. For example, Seyranian (2014) conducted an experimental study that randomly assigned college students to read different versions of a message by a student leader advocating for their college campus to become 100% powered by renewable energy sources. One version of the message tied the idea of a renewable energy campus to the school's social identity (Whittier College) by using high levels of inclusive language to portray that renewable energy is a normative component of "who we are." Another version of the message tied the idea of a renewable energy campus to the individual's personal identity by replacing all inclusive terms with individualist terms (e.g., "we" was replaced by "you"). In this way, the personal and individual relevance of the message was being cued in students' minds in lieu of a collective focus. Results revealed that inclusive language was more likely than individual language to elicit positive emotions in students, evoke positive leadership perceptions, and to create the perception that renewable energy was an ingroup norm. It also increased students' intentions to engage in collective action to bring renewable energy to campus. Seyranian and Crano (2014) have largely replicated these results in a larger sample at another university. All in all, these studies on renewable energy underline the potentially important role of implicating social identity through inclusive language as a means of promoting support for conservation behaviors. Yet the social identity approach has not been tested in the context of promoting water conservation behaviors, particularly for affluent households. Therefore, the current study seeks to explore the effectiveness of implicating collective (i.e., social identity) or individual (i.e., personal identity) level identities for promoting water conservation.

4. Overview of the current research and hypotheses

The objective of the current research was to compare four different interventions to curb water consumption in an affluent neighborhood in Los Angeles County. An affluent neighborhood was selected for study because research shows that this demographic tends to live in larger houses and consume much more water than low-income households (Corral-Verdugo, 2002). Households were randomly assigned to receive one of four possible communication interventions. The first intervention was drawn from the *knowledge deficit model* and provided households with a series of water saving tips. The second intervention employed *social normative feedback* by providing households with feedback about their water usage compared to their immediate neighborhood, along with social approval (happy face) if they were above the mean or social disapproval (sad face) if they were below the mean. The third intervention drew from social identity framing theory (Seyranian, 2013) and provided households with a short communication that linked water conservation behaviors to local city identity with high levels of inclusive language. The fourth intervention provided households with exactly the same communication as the social identity framing one, except that it employed personal identity language ("I", "you") in lieu of inclusive language to emphasize individual motivators and not collective ones. Each household's actual water consumption was measured at baseline (pre-intervention), in the short-term (1 week post intervention), and the long term (4 weeks post-intervention). In line with previous research, we predicted that: (a) compared to the other three interventions, the knowledge deficient approach would be the least likely to curb water usage over time; and (b) that the social norms and social identity interventions would be more effective in curbing water usage over time than the other interventions.

5. Method

5.1. Participants

Four hundred and seventeen households from a census tract in Los Angeles County were invited to participate in the current study. The census tract comprised 2.4 square miles with a total of 2632 households (Census, 2011). This census tract was selected because it represented a relatively more affluent neighborhood in the county of Los Angeles, with an average household income of $172,562 (Census, 2011). According to the Census (2011), the average family size in the census tract was 2.91 individuals. Additionally, the median age in the census track was 43.1 years, with a racial breakdown of 68% White, 3% African American, 20% Asian, and 9% other. Approximately 15% were Hispanic or Latino. Most of the inhabitants of the census tract had some type of higher education; 67% had earned a bachelor degree or graduate/professional degree, 20% had an associate degree or some college, 8% had a high school degree, and 5% did not have a high school degree.

All homes in the sample were verified as single-family households. Of the 417 households invited to participate in the study, seven households elected to withdraw from the study. Thirty-six households were also withdrawn from the sample for one of the following reasons: (a) household water meters were not easily accessible or were difficult to read ($n = 9$); (b) the house was on sale or appeared to be under major construction during the course of the study ($n = 2$); (c) household members did not use water between two points in time during the study, implying that they might have been out of town ($n = 10$); and (d) there were vast discrepancies in water usage between data collection points and in some cases the first reading was inexplicably larger than the second ($n = 15$), which may have been due to data entry errors or malfunctioning water meters. As such, the final sample for the current study comprised 374 households.

In terms of sample characteristics, houses in the final sample had an average of 4 bedrooms ($SD = 1.29$), 2.5 bathrooms ($SD = 1.11$), and spanned 2535 square feet ($SD = 949.96$). Note that house size was considerably larger in this sample than the average for California's entire housing stock, which is about 1607 square feet (see Energy Information Administration Residential Energy Consumption Survey, 2005). Households in the sample also utilized more water at baseline ($M = 830.28$ gallons a day, $SD = 67.90$) than the average house in the United States, which is approximately 400 gallons a day for a family of four (Environmental Protection Agency, 2008). All households in the sample had vegetation in their front lawns. No households in the sample had drought tolerant (xeriscaped) lawns at the time of the study, which are associated with less water use.

5.2. Procedure and water usage measures

The study consisted of an experiment with 3 (baseline, short term usage, long term usage) × 4 (social identity, personal identity, social normative feedback, information) mixed-factorial design, with water usage over time as a within-subjects variable and the interventions as the between-subjects factor.

All households were invited to participate in the current study via a letter on university letterhead explaining the nature of the study. Households were given the option to opt out of the study at any time without any negative consequences by contacting the research team by electronic mail, postal mail, or telephone. Less than one percent of the households choose to withdraw from the current study.

Actual household water usage was measured through readings of household water meters at four points in time. The study took place over the course of the summer. Four trained undergraduate research assistants conducted all water meter readings. Research assistants worked in teams of two individuals to collect data for all four data collection points. All households in the study were divided into two water meter reading routes with approximately 200 households per route. Each research team completed the same route with the same partner for all four data collection points. During each data collection point, each team walked along their assigned route and stopped to collect water meter data for each household along their route that was participating in the current study. The routes were organized so that individual meters could be read at approximately the same time for each data collection point. Each research team started their water meter route at 9:00 am.

All water meters in this neighborhood had a visible odometer display of water usage in cubic feet (1 cubic foot = 7.48 gallons). One research assistant recounted the water usage data out loud to the second research assistant team member, who recorded this information on a datasheet with his or her smartphone. This procedure was employed by each research team pair to record water usage for each household.

The four data collection points occurred over the course of an eight-week time period (see Table 1 for data collection timeline). At time 1, the research team recorded the first wave of water usage data to establish baseline water usage. To ensure reliable water meter readings between pairs of research assistants, each research assistant pair independently read and recorded water meter data from the first 29 houses of one of the data collection routes. The water meter readings from both pairs were identical, $r = 1.00$, $p < .0001$, implying perfect reliability between the pairs.

Time 2 took place three weeks after time 1. At this point, each household was randomly assigned to receive one of four possible communication interventions: information ($n = 93$), social identity ($n = 95$), social norms ($n = 93$), or personal identity ($n = 93$). In one day, research assistants delivered one of four possible communication interventions to each household in the study and recorded households' water usage at time 2. The difference between time 1 and 2 water usage was divided by 21 (the number of days of water usage) to establish a baseline of daily water usage prior to the study interventions.

Exactly one week later, the research assistants collected another round of water usage data at time 3. The difference between time 3 and time 2 water usage data was divided by 7 days to calculate *short-term* daily household water usage post-intervention. This variable consisted of one of our two dependent variables.

To examine long-term water usage post-intervention, at time 4, the research assistants collected a final wave of water usage data

Table 1
Data collection timeline.

Week 1	Week 4	Week 5	Week 8
Baseline data collection time 1	Interventions administered and time 2 data collected	Post-intervention data collection time 3	Post-intervention data collection time 4

four weeks (28 days) after the communication intervention (time 3). The difference between time 2 and time 4 water usage divided by 28 days (the number of days of water usage) constituted *long term* daily household water usage post-intervention. This was the second of our two dependent variables.

5.3. Interventions

Households were randomly assigned to receive one of four possible communication interventions. All households received a handout with a series of water saving tips for their bathrooms, kitchens, and lawns. These tips were drawn from suggestions posted on the websites of local water and power companies. For instance:

> "Run only full loads in the dishwasher and washing machine. Skip on pre-rinsing for your dishwasher. *Saves 300–800 gallons/month.*"
>
> "Don't defrost frozen foods with running water. Place frozen items in the refrigerator overnight. Saves 50–150 gallons/month."
>
> "Don't let the faucet run while you clean vegetables or fruit. Rinse them in a filled sink or pan. Saves 150–250 gallons/month."

In the information only condition, participants only received this handout. All other conditions received this handout of water saving tips along with one of three possible communications, which was printed on the other side of the handout.

In the social norms feedback condition, residential households received individualized feedback concerning their water usage. In line with previous research on social norms feedback (Schultz et al., 2007), households were informed whether their baseline water usage was above or below the neighborhood mean through the following statement: "Your home used an average of ____________ hundred cubic feet of water per day in the last week. You used _______ (more or less) water than the average home in your neighborhood." This descriptive and comparative feedback was supplemented with injunctive norms on the handout in the form of a happy face if the household's water usage was below the mean and a sad face if the household's usage was above the mean. It should be noted that the individual household mean usage was erroneously indicated in cubic feet (in the blank) in lieu of hundred cubic feet. Since the majority of individuals are unfamiliar with cubic feet measurements, it is highly likely that households focused on whether they used "more" or "less" water than others' in their neighborhood rather than the numeric value of the cubic feet feedback.

In the social identity framing condition, participants received a one-page communication about water conservation that followed a sequential three step framing process (Seyranian, 2013, 2014). First, in the *social identity frame unfreezing* phase, the communication tried to loosen resistance to change by outlining the water shortage problem facing Southern California and setting up a sense of urgency regarding the looming water crisis. To exemplify this phase of framing, consider the following excerpt from the message, "Simply put, our water supply is shrinking while our city's demand for water continues to grow. We could soon face a crippling scarcity." In the *social identity moving* phase, the communication encouraged readers to adopt water conservation behaviors by emphasizing that pro-environmental behavior and sustainable policies constitute an important a part of "who we are" and "what we stand for" as a city. It also linked city residents' water conservation behaviors to their local city identity ("this is how we act"). An excerpt from the social identity moving phase read:

> Starting from our environmentally friendly architecture to our clean city vehicles and green building programs, caring for our environment is part of who we are … That's why with looming water shortages and predictions of long-term drought, our city has crafted its most comprehensive water resource plan ever … Residential water conservation is a critical part of that plan.

Finally, in the *social identity freezing* phase, the communication sought to cement the link between local city identity and water conservation by positively affirming local city identity and summoning residents to engage in water conservation for the good of their local city.

> That's why we need help – we are asking everyone to contribute for the good of our city.
>
> Starting today, let's do our absolute best to conserve our precious water resources! We are including a list of expert tips on conserving water – please read them and integrate as many of these features as possible into your household and lifestyle.

Of note, the social identity communication sought to render the local city identity salient in two ways: (a) employing a high level of inclusive language ("we", "us" "local city identity", "residents"), which is a central communication strategy in rendering salient a particular social identity (Seyranian, 2013, 2014; Seyranian & Bligh, 2008); and (b) including a graphic logo related to the local city identity and the city name on top of the communication.

In the personal identity condition, residents received the same written communication as the social identity condition with two major differences. The personal identity communication used individual language ("I", "you") in lieu of inclusive language and did not include a graphic logo and city name. For example, the following sentence in the social identity communication had two inclusive terms (in italics), "Starting today, let's do *our* absolute best to conserve *our* precious water resources!" In the personal identity condition, the inclusive terms were replaced with individual language (in italics), "Starting today, do *your* absolute best to conserve *your* precious water resources!" In this way, the personal identity communication aimed to render salient individual and personal motivators to engage in water conservation instead of a collective one. The three interventions (social norms, social identity, personal identity) consisted of our three focal independent variables, with information-only as a reference group.

6. Results

Descriptive statistics on water usage by intervention condition, shown in Table 2, suggest that water usage spiked for the information-only condition after the intervention and remained high for the duration of the study. In contrast, water usage appears

Table 2
Water usage by intervention condition.

	Baseline		Short-term		Long-term	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Social identity	118.26	64.68	119.88	69.86	122.43	68.99
Personal identity	107.57	63.96	111.18	65.14	110.34	68.86
Social norms	110.36	58.65	109.34	61.95	113.49	66.66
Information only	110.26	82.60	155.28	444.34	128.16	145.80

Note. All values are in cubic feet per day.

to have stayed roughly constant in the other three conditions. These descriptive results suggest the possibility of an effect for the social identity, personal identity, and social norms conditions relative to the information-only condition; we explore this possibility in more detail in our multivariate models.

To test the hypotheses directly, we used two parallel series of ordinary least-squares regressions, one for short-term daily household water usage, and one for long-term. We began each series of analyses by simply regressing the post-intervention water usage on a set of three indicators, one for each of the social norms feedback, social identity, and personal identity conditions (Model A). Next, to improve statistical precision, we added a control for baseline water usage (i.e., average water usage prior to the intervention; Model B). We viewed the estimates from Model B as the most precise estimates of the intervention effect.

Moving past these main models, we added several additional control variables, which are thought to be related to households' water usage. The purpose of this was to explore the possibility that the effects of the interventions on water usage may be explained by differences between the four conditions in house size. These control variables include square footage, the number of bedrooms (perhaps a rough proxy for the number of residents), and the number of bathrooms (Model C).

Our final models were intended to identify the conditions under which the interventions may be more or less effective. Thus, we explored the extent to which the intervention effects appear to vary across levels of baseline water usage. To the previous models, we added interaction terms between baseline water usage and each of the three intervention indicators (Model D). A statistically significant coefficient on the interaction term suggests that the intervention effect differed depending on baseline water usage.

6.1. Short-term water usage

Table 3 shows the results of the four models for short-term water usage. With no control for baseline water usage, Model A indicated no statistically significant effect of any of the three interventions relative to the information-only condition. The intervention effects ranged in magnitude from 35 to 44 cubic feet per day, each favoring the intervention conditions over the information-only condition, but again none of these were statistically significant.

To improve precision, Model B included a control for baseline water usage (i.e., daily average water usage preceding the intervention). Baseline water usage was a strong predictor of post-intervention water usage ($\beta = 0.65$, $p < .001$). After controlling for baseline water usage, the intervention effect for the social identity intervention was a statistically significant 0.23 standard deviations ($p < .05$). Neither of the other two intervention effects (personal identity and social norms) was statistically significant at the $p = .05$ level. However, a post-hoc comparison indicated that we could not reject the null hypothesis that the three intervention effects (social identity, personal identity, social norms) were equal in magnitude $F(2, 369) = 0.17$, $p = .85$.

Model C added controls for household characteristics, none of which were significantly related to water consumption after controlling for baseline water usage.

Finally, Model D explored whether the intervention effects were moderated by baseline water usage. Prior to including the interactions, the baseline water usage was centered around its grand mean (110.48 cubic feet per day), as is true in all previous models. All three of the interaction terms were statistically significant and of approximately equal magnitude. Fig. 1 illustrates this interaction. This figure shows how the post-intervention water usage in each of the four groups varies based on baseline water usage. That the

Table 3
Regression models for short-term effects of water conservation interventions.

	Model			
	A	*B*	*C*	*D*
Social identity intervention	−35.41	−52.94*	−51.42*	−48.25*
	−0.16	−0.23*	−0.23*	−0.20*
	(33.37)	(25.37)	(25.51)	(18.93)
Personal identity intervention	−44.11	−38.22	−37.80	−46.70*
	−0.19	−0.17	−0.17	−0.20*
	(33.55)	(25.48)	(25.64)	(19.11)
Social norms intervention	−45.95	−46.17	−45.07	−48.80*
	−0.20	−0.20	−0.19	−0.22*
	(33.55)	(25.48)	(25.67)	(19.18)
Baseline water usage		2.19***	2.37***	4.48***
		0.65***	0.70***	1.35***
		(0.13)	(0.15)	(0.17)
Social identity × baseline				−3.44***
				−1.03***
				(0.26)
Personal identity × baseline				−3.42***
				−1.03***
				(0.27)
Social norms × baseline				−3.39***
				−1.02***
				(0.28)
Square footage			−0.03	−0.03
			−0.12	−0.10
			(0.02)	(0.01)
Bedrooms			0.94	−2.21
			0.01	−0.01
			(9.85)	(7.43)
Bathrooms			−2.40	2.05
			−0.01	0.003
			(11.67)	(8.79)
Constant	156.29***	158.33***	234.49***	227.49***
	(23.72)	(18.02)	(34.46)	(26.01)
R-squared	0.00	0.43	0.44	0.68
F	0.81	69.16	40.99	78.43
$p > F$	0.49	0.00	0.00	0.00
n	374	374	371	371

Note. *$p < .05$, **$p < .01$, ***$p < .001$. Values in each cell are unstandardized regression coefficients, standard errors, and standardized regression coefficients. Dichotomous variables remain unstandardized, all other variables are standardized.

coefficients were each negative indicated that the intervention effect for each of the three interventions (relative to the information-only control) was significantly greater for households with more baseline water usage as compared to houses with lower baseline water usage. Information-only households at the mean baseline usage used an average of 222.39 cubic feet per day post-intervention; this intercept is significantly different from zero

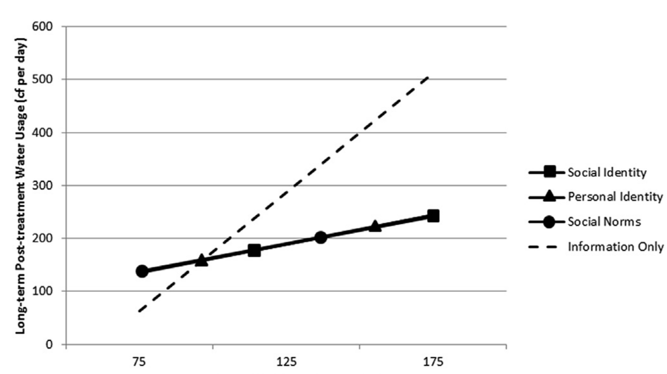

Fig. 1. The figure displays long term water usage as a function of baseline water usage and the interventions. Note that in the figure, the lines for social identity, personal identity, and social norms are almost completely overlapping.

($t = 8.77$, $p < .001$). For information-only households, there was a statistically significant main effect of baseline usage ($b = 4.48$, $t = 26.57$, $p < .001$). In contrast, social identity households at the mean baseline usage level used an average of 174.13 cubic feet per day post-intervention (the difference with information-only households is statistically significant $b = -48.25$, $t = -2.55$, $p = .01$), and each additional cubic foot per day of baseline usage was associated with just 1.04 cubic feet per day of post-intervention usage (a statistically significant interaction effect of $b = -3.44$, $t = -13.40$, $p < .001$). The interpretations for the other two interventions are quite similar. As the graph clearly demonstrates, the social identity, personal identity, and social norms groups are not distinguishable from one another at any point on the baseline usage continuum, as their lines fall nearly on top of one another.

6.2. *Long-term water usage*

Table 4 shows the results of the four models for long-term water usage. As with the model for short-term water usage, there was not a statistically significant effect prior to controlling for baseline water usage. The coefficients in these models were much smaller (all less than 20) than the models for short-term usage.

To improve precision, Model B included a control for baseline water usage. Again, the inclusion of the baseline usage improves precision — all three intervention effects were statistically significant in Model B. After controlling for baseline water usage, the social identity ($\beta = -0.17$, $p < .01$), personal identity ($\beta = -0.17$, $p = .02$), and social norms ($\beta = -0.15$, $p = .03$) interventions all showed reduced water usage relative to the information-only control. Again, a post-hoc comparison indicated that we could not reject the null hypothesis that the three intervention effects were equal in magnitude $F(2, 368) = 0.01$, $p = .99$.

Model C adds controls for household characteristics, none of which were significantly related to water consumption after controlling for baseline water usage.

Finally, Model D again explored whether the intervention effects were moderated by baseline water usage. The interpretations were quite similar to the short-term water usage results, as all three interaction terms were statistically significant. For all three interventions, the intervention effect appears larger for households with larger pre-intervention water usage. Post-intervention water usage in each of the four groups varies based on baseline water usage. In particular, the long-term water usage for households in the information-only group is generally greater than that in the other three groups at most levels of baseline water usage. However, this difference is greatest for houses with the highest baseline water usage. Similar to short term findings, the social identity, personal identity, and social norms groups were not distinguishable from one another at any point on the baseline usage continuum. Given the parallel findings between the short-term and long-term results, a graph (as Fig. 1) for the long-term water usage is not included.[1]

Table 4
Regression models for long-term effects of water conservation interventions.

	Model			
	A	*B*	*C*	*D*
Social identity intervention	−5.73	−15.52**	−15.29**	−14.28**
	−0.06	−0.17**	−0.16**	−0.15**
	(13.68)	(6.30)	(6.54)	(5.55)
Personal identity intervention	−17.82	−15.69*	−15.73*	−16.95**
	−0.19	−0.17*	−0.17*	−0.18**
	(13.79)	(6.34)	(6.44)	(5.59)
Social norms intervention	−14.67	−14.79*	−14.84*	−15.67*
	−0.15	−0.16*	−0.16*	−0.17*
	(13.75)	(6.32)	(6.43)	(5.58)
Baseline water usage		1.22***	1.23***	1.64***
		0.88***	0.89***	1.19***
		(0.03)	(0.04)	(0.05)
Social identity × baseline				−0.67***
				−0.48***
				(0.08)
Personal identity × baseline				−0.65***
				−0.47***
				(0.08)
Social norms × baseline				−0.67***
				−0.49***
				(0.08)
Square footage			−0.03	−0.01
			−0.03	−0.02
			(0.004)	(0.01)
Bedrooms			0.93	0.34
			0.013	0.01
			(2.47)	(2.14)
Bathrooms			1.43	2.30
			0.02	0.03
			(2.92)	(2.53)
Constant	128.16***	129.86***	130.84***	129.55***
	(9.72)	(4.47)	(8.76)	(7.50)
R-squared	0.01	0.79	0.79	0.84
F	0.71	346.68	195.18	193.96
p > *F*	0.55	0.00	0.00	0.00
n	373	373	370	370

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Values in each cell are unstandardized regression coefficients, standardized regression coefficients, and standard errors. Dichotomous variables remain unstandardized, all other variables are standardized.

7. Discussion

Overall, the results of the study suggested that for higher water users, households exposed to information alone (knowledge deficit approach) used the highest quantity of water both in the short term and in the long run compared to high water users in all other conditions. These results fall in line with previous research (e.g., Schultz et al., in press) that suggests that information alone may not be as effective in promoting water conservation as other communication approaches. This finding may be of interest to the applied domain as many water conservation campaigns spearheaded by water management companies and municipalities are still employing the knowledge deficit approach. Our results suggest that the knowledge deficient approach may not only be an ineffective strategy, but it may even be counterproductive. Over time, an inspection of the means for the information condition indicated an increase of water usage — a trend that was generally not observed for households who received the other three interventions.

This trend for the information only condition could be attributed to several factors. First, high temperatures are associated with more water usage (Balling & Gober, 2007). Since this study was

[1] We also conducted a parallel set of repeated-measures ANOVAs to test the hypotheses in the study. The results of the ANOVAs were in line with those presented in the text for long-term water usage. However, the results did not show a significant effect for short-term water usage (i.e., the ANOVA results parallel to models B and C differed from the OLS results), although it should be noted that the pattern of results was largely the same. Additionally, results only revealed a significant pairwise comparison for short-term water usage such that participants in the social identity condition employed less water than those in the information condition. No other pairwise comparisons were statistically significant. The reason for the difference between the ANOVA results and the OLS results may be that the three interventions had very similar effects relative to the information-only group, so the test of joint equality in the ANOVA could not be rejected. It is also possible that the ANOVA did not have enough power to detect significant effects for short-term effects. We elected to present the OLS results because it represented a direct test of each intervention versus the information-only control and provided clear and straightforward intervention effect estimates.

conducted over the summer months of July to August with August being the hottest month of the year in Los Angeles, households in all conditions likely had a natural inclination to increase their water usage over the course of the study. As such, the increase in water usage in the information condition could be attributed to the increase in temperature and not attributed to the information intervention. In other words, perhaps households did not respond to the information only condition and this condition became similar to a control group. On the other hand, the interventions in the other three conditions may have effectively attenuated the natural proclivity to use more water with higher temperatures, which made water usage look flat for each intervention across time. Second, the information condition may have created a boomerang whereby households increased their water usage over time, perhaps due to reactance (Brehm, 1996). While this point is speculative, it is possible that without an additional persuasive message, individuals exposed to the knowledge deficit approach felt that the water saving tips required considerable behavioral change and conservation, which was threatening their freedom to consume as much water as they pleased. In striving to re-establish their freedom, individuals may have reacted by consuming even more water than before. A third possibility is that the first and second explanations are not mutually exclusive. That is, a combination of a natural proclivity to use more water during higher temperatures and reactance could have played a role in the increased water usage in the information condition. Future research should test the plausibility of these potential explanations. Regardless of the reason why the information condition resulted in more water usage over time, the results clearly show that the social norms, social identity, or personal identity approaches are more worthwhile alternatives than the knowledge deficit approach for promoting water conservation.

Our results indicated that higher water consumers at baseline who were exposed to social norms intervention used less water in the short term and long term compared to the information only condition. Thus, our results corroborated previous research showing that normative influence is a more effective strategy in reducing water usage than information alone (e.g., Schultz et al., 2007). The social norms approach capitalizes on the idea that individuals are attuned to both descriptive and injunctive norms and change their behavior to be consistent with social rules and prescriptions from reference groups. Water and power companies (e.g., Opower) are increasingly adopting this strategy by providing households with comparative feedback in their monthly billing statements.

Beyond replicating previous findings, a novel contribution of the current study is in introducing two new communication approaches that may be as effective as normative feedback in influencing water consumption. The social identity framing approach (Seyranian, 2013, 2014; Seyranian & Bligh, 2008) suggests that water conservation may be promoted by using high levels of inclusive language to communicate that water conservation is a normative component of “who we are” and “how we act” as a community. Results showed a similar pattern of results for social identity as social norms in that high water consuming households in the social identity condition used less water than high water consuming households in the information only condition both in the short and long term. The social norms approach and the social identity approach may be similarly persuasive because they are both tapping into the influence potential of group-level norms on behavior. The main difference in the approaches is that social norms allude to more general “neighborhood” norms and includes comparative numerical feedback whereas the social identity approach targets a particular group and involves a short message constructed with group level rhetorical and visual constructs.

While both approaches seem to work in similar ways on high water consumers, future research may investigate the conditions or specific target groups where each approach may be most effective. For example, perhaps the social norms approach may be more effective than the social identity approach for people who do not highly identify with a specific local identity. The social identity approach may resonate more for individuals who highly identify with the referent group or who feel that their privacy is affected by the feedback process. The social identity approach may also be more amenable to being employed during crisis conditions (e.g., water shortages) as it does not require a lengthy feedback process. It consists of a brief communication and is relatively cost-effective and quick to implement. Over time, however, people may grow tired of reading multiple social identity communications but they may remain open to consistent comparative feedback on their water usage as their usage may fluctuate. As such, the social norms feedback process may help to sustain lower water usage over time during more stable conditions. These speculations await verification by future research.

A surprising finding was that implicating personal identity in lieu of social identity resulted in a similar pattern of results as the social norms approach and social identity approach. In promoting support for environmentally sustainable policies, previous research has shown that social identity was more persuasive in garnering support for renewable energy than personal identity (Seyranian, 2014). In the context of fostering more sustainable behavior among high water users, however, it seems that implicating either social or personal identity was more useful than information alone.

Overall, more research is needed to examine why the three strategies produced similar effects on water usage. One reason may be because water “carries important aesthetic, social status, and recreational affordances, which are deeply ingrained in upper middle-class lifestyles” (Harlan et al., 2009, p. 705). Water consumption is not just a physical necessity – it also meets individuals' psychological needs for identity, status, and symbolic social competition (Corral-Verdugo et al., 2012). To achieve the goal of water conservation, behavioral interventions may need to do more than just provide information on methods to save water. Interventions need to divert the social needs of individuals (e.g., status, identity) from water consumption to water conservation. This is exactly what all three of the strategies in the current study may have accomplished. Each intervention supplemented water saving tips with social information (social norms, social or personal identity) that linked the idea of water conservation to desirable social factors, thereby garnering the necessary impetus for individuals for overcome resistances and barriers to water conservation. As such, water conservation became socially meaningful and tied to a higher purpose.

7.1. Limitations

One of the strengths of the current study was that it tested water consumption one week post intervention (short term usage) and approximately four weeks post intervention (long term usage). However, the study was conducted over the summer months, when water usage typically increased. It is still unclear how increased temperatures affected water usage and how long the effects from the interventions persist. It is important to test different times of year to determine the impact of seasonal variability of water usage on various communications approaches. In addition, future research in this area may be well advised to build in additional post-tests at two months, six months, or a year after the interventions to gain an understanding of how often interventions should be implemented to ensure efficient water use in residences.

It is important to develop our understanding of how households in the conditions respond to temperature variations over time.

It should also be noted that the error in social norms comparative feedback condition could have impacted the results. Recall that water usage for both individual households and the neighborhood mean was erroneously indicated in cubic feet (in the blank) instead of hundred cubic feet. This may have confused some households who had knowledge of the cubic feet metric and led them to believe that their water usage and the neighborhood's was much higher than reality. However, since individuals tend to be much more familiar with gallons than cubic feet, it is highly likely that most households did not focus on the numeric value of the actual cubic feet feedback. Rather, they may have been more attentive as to whether they used “more” or “less” water than those in their neighborhoods. While this is highly likely, it would still be prudent to replicate the results obtained in the current study for the social norms feedback condition.

Another limitation of the current study was that only behavioral data (i.e. water usage) was obtained in the current study. It would have informative to supplement behavioral data with interview or survey data to better comprehend the role of demographics in water conservation (e.g., age, education), attitudinal outcomes of each intervention, the role of environmental beliefs (Corral-Verdugo, Bechtel, & Fraijo-Sing, 2003), and the potential barriers of water conservation in this population. Interview or survey data may also allow researchers to check whether the communications were indeed read by each household and which members of the households read the communications.

8. Conclusion

The current study implemented four water conservation interventions in an affluent sample in Los Angeles because affluent households tend to consume large quantities of water (Corral-Verdugo et al., 2012). In this population, the knowledge deficit model was the least effective means of promoting more sustainable water usage behavior both in the short and long term. The current research suggests that implicating social norms, social identity, or personal identity may provide more viable options to encourage water conservation. These more socially oriented interventions may assist consumers to surmount resistances to water conservation that are motivated by social factors — a feat which knowledge alone is unlikely to accomplish. Overall, socially oriented interventions appear to be promising area of future research in promoting water stewardship and reducing water waste. With continued research efforts in this area, we will move closer toward ensuring a more sustainable water future for us all.

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