water

MDPI

Article

Historical Self-Comparison of Water Consumption as a Water Demand Management Tool

Yurina Otaki [1,*], Hidehito Honda [2] and Kazuhiro Ueda [3]

[1] Graduate School of Social Sciences, Hitotsubashi University, Tokyo 186-8601, Japan
[2] Department of Psychology, Yasuda Women's University, Hiroshima 731-0153, Japan; hitohonda.02@gmail.com
[3] Graduate School of Arts and Sciences, the University of Tokyo, Tokyo 153-8902, Japan; ueda@gregorio.c.u-tokyo.ac.jp
* Correspondence: yurina.otaki@r.hit-u.ac.jp

Received: 20 March 2019; Accepted: 19 April 2019; Published: 22 April 2019

Abstract: This study aimed to identify effective presentation methods used for historical self-comparisons of residential water consumption that will lead to the efficient use of water. To compare each household's current and previous water consumption, illustrations of water droplets were used as feedback every other week for five months, with the number of water droplets indicating an increase or decrease in water consumption. When only using the same blue water droplets, there was no change in water consumption. However, when using yellow and red droplets in cases of increased water use, we observed that water consumption declined. By improving the method of communication, historical self-comparisons of water consumption can realize an efficient use of water at all consumption levels.

Keywords: water demand management; historical self-comparison; consumption feedback; Nudge

1. Introduction

Information-based residential water demand management programs have been developed to motivate people to use water efficiently. Various kinds have been tested, including water-saving campaigns based on historical usage and providing tips, while the recent advent of 'smart meters' for water has led to an active focus on consumption feedback.

As information campaigns can be deployed quickly and implemented with relatively low cost, policymakers are apt to use them for water management. However, such campaigns can be effective only in places with water shortages [1,2], as the willingness to conserve water only arises in situations of water scarcity [3]. Moreover, their effectiveness has been assessed only for short periods [4,5]. These findings suggest that information campaigns could be most effectively implemented to address relatively short-term supply shortages, such as droughts and seasonal peak demand [5].

Providing tips about how to save water effectively (e.g., turning off the tap when cleaning teeth, washing full machine loads of clothes) has not necessarily yielded consistent results. Some studies reported no effect on water consumption [6–8], while others insisted the opposite [9,10]. The effectiveness of providing such tips is still under consideration.

Regarding consumption feedback, a growing number of studies have recently reported that social comparisons of residential water consumption to that of one's neighbours lead to water savings. Among the various methods used to represent comparisons, emoticons [7,11–13], average values for neighbours [14], the percentage of similar households engaging in a range of water-saving actions [9], and combinations thereof [7,15,16] were shown to be effective. That is, the perception of externalities motivates water savings [17]. However, most of these studies only demonstrated water savings in the short term, with less being known about the long-term impacts [11,18]. A few studies have observed the continuous effect of social comparison. One reported that the effect declined, but significantly remained detectable six years later because of water-saving infrastructure and changing habits [18]. Another study reported that a treatment effect was still significantly detectable more than two years after the intervention [14]. Social comparison has been used as a primary tool to guide action in various contexts [19], and a number of field studies in the residential energy consumption field—the area most similar to that of water consumption—suggest its efficacy [20,21].

However, social comparisons sometimes create uncomfortable feelings, especially where downward evaluations occur [22]. Also, as water consumption is a type of personal data, the risk of an invasion of privacy, as happened in the Netherlands, will be raised in proportion to the extent of processing such information [23,24].

Historical self-comparison has also been a commonly-used tool. Water utilities all over the world have already introduced the historical comparison of water consumption with the previous year or previous billing periods together with the cost. People have a greater interest in and respond more to historical self-comparisons than they do to normative ones [25,26]. However, as most of the previous studies evaluated historical self-comparison together with social comparison [27], it is difficult to establish the efficacy of historical self-comparison alone. Additionally, in contrast to research on social comparisons, self-comparison studies rarely examine the issue of how to visualise consumption.

Based on the outcomes of the survey above, this study was designed to investigate the efficacy of historical self-comparison as a water demand management tool.

2. Materials and Methods

2.1. Overview

This research aims to identify effective presentation methods used for historical self-comparison that will lead to the continuous efficient use of water. We used illustrations of water droplets to display increases and decreases in water consumption.

Firstly, a total of 633 households located in the Tokyo commuting area and randomly sampled from a roster of survey registrants within a research company were recruited into the study. Participants were randomly assigned to one of three groups: one control group and two intervention groups. As water smart meters have not been introduced in Japan, water consumption was monitored by water meter readings and the reporting by all participants once every two weeks over 24 weeks (i.e., 12 observations). Water consumption data obtained this way was used to evaluate changes in consumption and also to offer feedback to the intervention groups. Participants in the intervention groups received e-mails informing them of the historical self-comparison within four to five days of each observation. Water consumption changes significantly according to the season. In Tokyo, water consumption tends to increase during the summer (July and August) and winter (January and February) seasons. We assumed that changes in the control group's water consumption reflected seasonal variations, and we evaluated changes in the intervention groups relative to the control group.

At the end of the survey, participants were asked questions about how they had changed their water use and how they felt about the feedback.

2.2. Intervention

Intervention groups received the water droplet illustrations, as shown in Figure 1, every two weeks by e-mail. Water consumption for the previous two weeks was always represented with six water droplets. Water consumption in each two-week period was evaluated on an eleven-point scale using the numbers of water droplets to indicate the change rate from the previous two weeks to the most-recent two weeks. The more water consumption decreased (or increased), the fewer (or more) water droplets they received.

The difference between the two intervention groups was the colour used for the water droplets as shown in Figure 1. One group received blue water droplets only (thereby named 'blue drop group'). In the other group, the colour varied depending on the number of water droplets ('colour drop group'); blue water droplets were used when the level of water consumption was lower compared to the previous two weeks; yellow and red water droplets were used when water consumption exceeded that of the previous two weeks. For the blue drop group, the shade of blue did not change regardless of the number of drops. For the colour drop group, the shade of blue changed from light to dark as the amount of water used increased, and it then changed to yellow and finally to red to represent even greater increases in consumption.

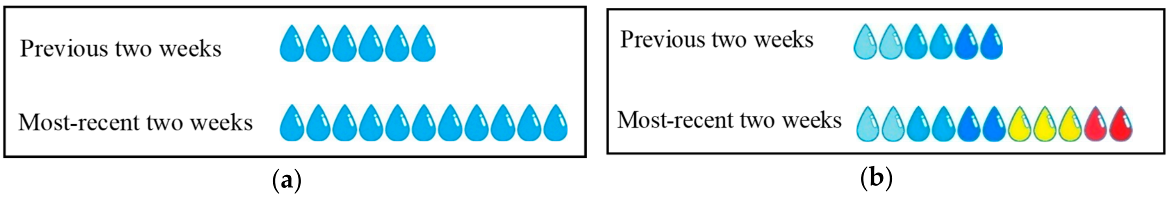

Figure 1. An example of the water droplet pictures shown to the intervention groups: (**a**) Illustration for the blue drop group; (**b**) Illustration for the colour drop group. The number of water droplets in the initial two weeks was always six. This was then changed to between one and eleven according to the rate of change from the previous period.

2.3. Water Consumption Data and Evaluation of Change

Water consumption data were collected from September 2017 to February 2018 except for the year-end and New Year holidays (i.e., 22 December 2017 to 5 January 2018). In addition, all data that were either extremely small or large were excluded using z values, which were calculated using water consumption during the survey period for each family. We excluded data whose z value was either greater than 2.5 or less than −2.5 from the analysis.

As the intervention started in October 2017, the data in September was defined as the initial consumption and the changes in water consumption for each household were evaluated as follows:

$$LRP_n = \log (C_n/C_0), \tag{1}$$

where C_0 is monthly water consumption in September, Cn is monthly water consumption after starting the intervention, and LRP_n is the log-transformed relative proportion (n = 10 (October), 11 (November), 12 (December), 1 (January), 2 (February)). An LRP_n less than zero indicated that water consumption had decreased compared to the initial value, whereas an LRP_n greater than zero indicated that it had increased. For example, for a household that used 200 L/capita/day in September and 250 L/capita/day in October, the LRP_{10} was 0.223.

We classified the patterns of increase and decrease in water consumption using the K-means clustering method. We determined the number of clusters by considering the trade-off between parsimony (i.e., as few clusters as possible) and informativeness (i.e., as many clusters as necessary). The total within the sum of squares (WSS) for different values of k was computed, and we found the most suitable k by looking for an 'elbow' in the curve (i.e., we examined whether by increasing the number of clusters, the reduction of WSS was sharp or not).

We also analysed influence by the quantity of water use. It is known that as the number of family members increases, total water consumption increases and per capita water consumption decreases. Tokyo metropolitan waterworks reports that daily water consumption per capita is 273 L (one-person household), 265 L (two-person household), 227 L (three-person household), 203 L (four-person household), 190 L (five-person household), and 188 (six-person household). To eliminate the influence of household size, we converted the water consumption per capita of each household in September into a value that was assumed to be for a one-person household. For example, if a three-person household used 300 L/capita/day, the converted value was 361 (300 × (273/227)). From this perspective, each household was designated as a 'high consumer' if greater than the median or a 'low consumer' if lower than the median, and we examined how this difference affected water usage.

2.4. Questionnaire

At the end of the survey, all participants were asked the following question: 'How much do you think that your water usage has changed?' They were required to respond using a ten-point scale (Figure 2). In addition, only the participants in the blue and colour drop groups were asked 'When you received the water droplet illustrations, how did it affect your intentions regarding water usage?' They answered using a ten-point scale, ranging from '1 = tried to reduce it' to '10 = tried to increase it'.

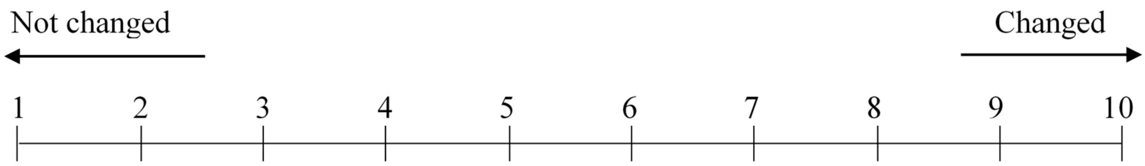

Figure 2. Example from the questionnaire: 'How much do you think that your water usage has changed?'

3. Results

3.1. Participants

Of the initial 633 households, a total of 479 (152 control, 167 blue drop, 160 colour drop) participated in and completed the study. The distribution of the family members and yearly household income level are described in Tables 1 and 2, respectively. A Chi-square test indicated that there was no statistically significant difference among groups (family size $\chi^2 = 1.9023$, $p = 0.984$; yearly income $\chi^2 = 6.5014$, $p = 0.369$). Initial water consumption (L/capita/day) also did not show significant difference among groups (Kruskal–Wallis $F = 0.2814$, $p = 0.869$). Median values of the control, blue drop, and colour drop groups were 195.0, 188.0, and 191.2 L/capita/day, respectively.

Table 1. Distribution of family size in each group.

Family Size	1	2	3	4	>5
Control	25	45	36	35	11
Blue drop	23	50	45	38	11
Colour drop	22	47	42	34	15

Table 2. Distribution of yearly household income level in each group.

Yearly Household Income	<4 Million JPY	4–6 Million JPY	6–8 Million JPY	>8 Million JPY
Control	38	32	32	50
Blue drop	25	38	37	67
Colour drop	26	35	37	62

3.2. Water Consumption Trends during the Intervention

As a result of the clustering analysis, we found that four clusters indicated the general patterns of the water consumption trends. Figure 3 plots the mean LRP_n from October to February for each cluster. We named the cluster that corresponds to the bottom line in the graph 'Decrease', as the water consumption tended to decline throughout the five months, especially after December. The clusters that correspond to the second and third lines from the bottom were named 'Slight Decrease' and 'Slight Increase.' We called the cluster at the top line 'Increase' as the water consumption increased since September, especially after December. Figure 4 shows the proportion of households classified into the four clusters. A Chi-square test indicated that there was no statistically significant difference between the control and blue drop groups (χ^2 = 1.3337, p = 0.721). It is therefore suggested that historical self-comparison does not cause a change in water usage even when using a visual expression that is easy to understand. On the other hand, there was a marginally significant difference between the control and the colour drop groups (χ^2 = 7.1058, p = 0.069). A residual analysis revealed that the colour drop group had relatively more households classified as 'Slight Decrease' (adjusted residual = 2.608). This suggests that the colour drop group households relatively decreased their water consumption and thus that adding colour elements to the visual expression of historical self-comparison led to water saving.

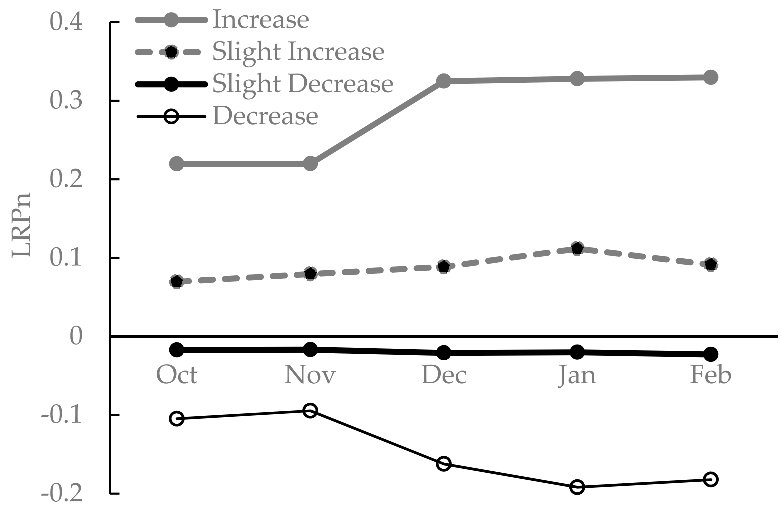

Figure 3. Transition of the median value of log-transformed relative proportions of each cluster for each month after the intervention started.

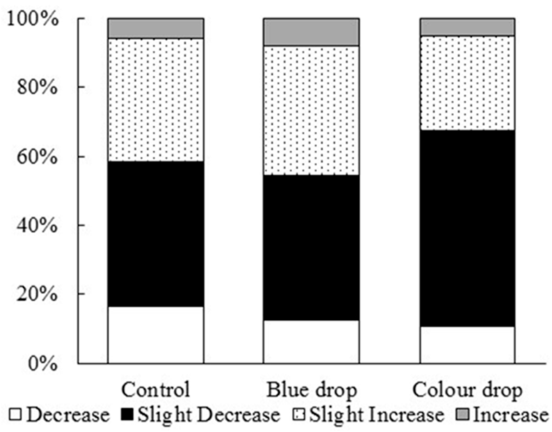

Figure 4. Proportion of households classified into four clusters.

Past research using social comparison feedback reported that high consumers tended to save water as a result of such an intervention [11,20]. If this is the case, there is a possibility that the ratio of high consumers is high in the 'Decrease' and 'Slight Decrease' clusters of the colour drop group, and the ratio of low consumers is high in the 'Slight Increase' and 'Increase' clusters of this same group. Table 1 shows the number of high and low consumers in each group for each cluster, and it displays the results of the Fisher's exact test. As shown in Table 3, there is no significant difference in the ratio of high–low consumers in all clusters. In spite of the fact that there was no significant difference in the proportion of high–low consumers in any cluster, the colour drop group households relatively decreased their water consumption. It can thus be said that the decrease of water consumption in the colour drop group was caused not by the deviation in consumption for every group but by the self-comparison feedback itself.

Table 3. Low and high consumers of each group for each cluster and the result of statistical analysis.

	Decrease		Slight Decrease		Slight Increase		Increase	
	High Consumer	**Low Consumer**	**High Consumer**	**Low Consumer**	**High Consumer**	**Low Consumer**	**High Consumer**	**Low Consumer**
Control	14	11	32	32	28	26	3	6
Blue drop	11	10	41	29	27	36	3	10
Colour drop	6	11	51	40	22	22	1	7
p value	0.4352		0.6188		0.6216		0.7572	

Note: The line of control, blue drop and colour drop shows the number of households, and the line of *p* value shows the result of the Fisher's exact test.

3.3. Questionnaire Survey

Figure 5 shows the distribution of answers for the first question about the change in water usage ('How much do you think that your water usage has changed?'). The Wilcoxon rank sum test indicated that participants in the blue and colour drop groups tended to feel that their water use had changed (W = 10,422, p = 0.010 for the blue drop group; W = 9614, p = 0.002 for the colour drop group). The second question about their intentions concerning the degree of change in quantity ('When you received the water droplet illustrations, how did it affect your intentions regarding water usage?') showed no significant difference between the blue and the colour drop groups (W = 11,859, p = 0.1478).

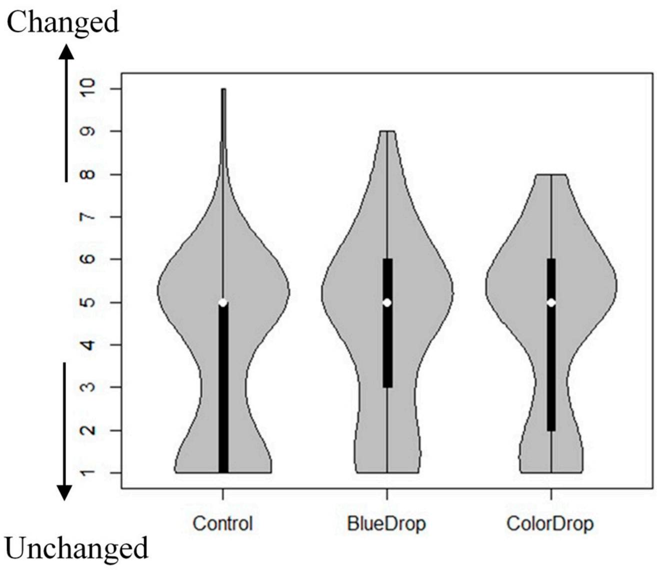

Figure 5. Distribution of answers to the question about the change in water usage ('How much do you think that your water usage has changed?').

4. Discussion

It was assumed that there would be no change in water consumption if we compared it with past consumption without doing anything innovative. In this study, although increases and decreases in consumption were expressed in an easy-to-understand manner based on the number of blue water droplets, there was no effect. On the other hand, by adding colour as an attention-awakening tool, the proportion of 'Slight Decrease' relatively increased compared with the control group; that is, water consumption was reduced. As past cognitive studies have indicated that the colour red can activate an avoidance motivation more so than the colour blue [28], this study also suggests its effectiveness. There is also a possibility that using colour made the amount of water use easy to understand, and that this is what actually led to the decrease in water consumption. In order to examine this, it is necessary to investigate what happens when a drop is presented in the same way using colours that do not directly prompt attention.

It is noteworthy that the feedback on historical self-comparison using colour has the effect of promoting continuous water conservation. While the median value of each cluster remained unchanged throughout the intervention period as shown in Figure 3, the 'Slight Decrease' in the colour drop group increased relative to the control group, meaning that the effect of the colour drop remained effective. This kind of small ingenuity used to encourage a behavioural change is called a 'Nudge', defined as any factor that significantly alters the behaviour of humans [29], and has been applied to induce unconscious behavioural changes such as healthy food selections and energy saving behaviour. Our study demonstrated a continuous effect from this 'Nudge', albeit only over a relatively limited five-month period; this represents an important outcome given that previous studies had indicated that a 'Nudge' does not exhibit such continuity [30,31].

The other notable point is that water saving occurred regardless of the level of water consumption. In the case of feedback using social norms, it has been reported that only the usage of high consumers changed [7,11]. Historical self-comparison is advantageous because it works for all types of water consumers to support them in saving water.

In the questionnaire survey, the participants who had received the water droplet illustration feedback tended to say that they changed their water consumption. In previous studies of social comparison feedback with emoticons, high consumers who had reduced their water consumption said in the questionnaire that they had not changed their usage [11]. That is to say, while social comparison prompted unconscious water conservation, historical self-comparison prompted conscious conservation of water. Furthermore, although most participants who were assigned to receive the feedback thought to reduce their water use, only those who received the coloured water droplets illustrations actually did so. This indicates that unconscious induction is important for behaviour change.

5. Conclusions

By improving the method of communicating historical self-comparisons of water consumption, we indicate possible ways to realize an efficient use of water at all consumption levels. Here, we have demonstrated the effectiveness of using historical self-comparison in this context, a situation where using social comparison based on personal data regarding water consumption could prove difficult. Moreover, water saving was observed for several months, unlike usual 'Nudge' attempts whose effects did not last in the long run. The results of this study can be applied to water demand management, not only in cases of temporary but also of chronic insufficiency of water supply. One limitation of the current study is that it was only implemented over five months; a trial that takes place over a full year (or even longer) might prove more informative. Another limitation is that approaches like this are usually considered in the context of smart metering systems; however, it can also be incorporated into the current paper-based billing system. Since it is a very simple method that can be easily introduced, it may be better to examine how much effect it will have on paper-based notifications.

As long as people look at such feedback, their water consumption changes. As the participants of this study were survey registrants with a research company, such participants may have been more highly motivated to check the presentation. Therefore, in the case of the general population, the motivation may not be as high. An objective for the future would be to consider how we could increase the proportion of the general public who would continuously view such feedback. In addition, the frequency of feedback (i.e., every day, once a week, once a month) and type of media (i.e., paper, e-mail, web site, application) should be considered before implementation.

Author Contributions: Conceptualization, Y.O., H.H. and K.U.; methodology, Y.O., H.H. and K.U.; validation, Y.O., H.H. and K.U.; formal analysis, Y.O. and H.H.; investigation, Y.O. and H.H.; resources, Y.O.; data curation, Y.O.; writing—original draft preparation, Y.O.; writing—review and editing, H.H. and K.U.; visualization, Y.O.; supervision, K.U.; project administration, Y.O.; funding acquisition, Y.O., H.H. and K.U.

Funding: This research was funded by JSPS: Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), grant number JP18H04324 and Scientific Research (C), grant number JP15K00653.

Acknowledgments: The authors thank the reviewers for helpful comments.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Inman, D.; Jeffrey, P. A review of residential water conservation tool performance and influences on implementation effectiveness. *Urban Water J.* **2006**, *3*, 127–143. [CrossRef]
2. March, H.; Hernandez, M.; Saurí, D. Assessing domestic water use habits for more effective water awareness campaigns during drought periods: A case study in Alicante, Eastern Spain. *Nat. Hazards Earth Syst. Sci. Discussi.* **2014**, *2*, 6859–6881. [CrossRef]
3. Aisbett, E.; Steinhauser, R. Maintaining the Common Pool: Voluntary Water Conservation in Response to Varying Scarcity. *Environ. Resour. Econ.* **2014**, *59*, 167–185. [CrossRef]
4. Sauri, D. Water Conservation: Theory and Evidence in Urban Areas of the Developed World. *Annu. Rev. Environ. Resour.* **2013**, *38*, 227–248. [CrossRef]
5. Katz, D.; Grinstein, A.; Kronrod, A.; Nisan, U. Evaluating the effectiveness of a water conservation campaign: Combining experimental and field methods. *J. Environ. Manag.* **2016**, *180*, 335–343. [CrossRef]
6. Ferraro, P.J.; Price, M.K. Using nonpecuniary strategies to influence behaviour: Evidence from a large-scale field experiment. *Rev. Econ. Stat.* **2013**, *95*, 64–73. [CrossRef]
7. Schultz, P.; Messina, A.; Tronu, G.; Limas, E.; Gupta, R.; Estrada, M. Personalized normative feedback and the moderating role of personal norms: A field experiment to reduce residential water consumption. *Environ. Behav.* **2014**, *48*, 686–710. [CrossRef]
8. Seyranian, V.; Sinatra, M.; Polikoff, M. Comparing communication strategies for reducing residential water consumption. *J. Environ. Psychol.* **2015**, *41*, 81–90. [CrossRef]
9. Fielding, K.S.; Spinks, A.; Russell, S.; McCrea, R.; Stewart, R.; Gardner, J. An experimental test of voluntary strategies to promote urban water demand management. *J. Environ. Manag.* **2013**, *114*, 343–351. [CrossRef]
10. Liu, A.; Giurco, D.; Mukheibir, P. Urban water conservation through customised water and end-use information. *J. Clean. Prod.* **2016**, *112*, 3164–3175. [CrossRef]
11. Otaki, Y.; Ueda, K.; Sakura, O. Effects of Feedback about Community Water Consumption on Residential Water Conservation. *J. Clean. Prod.* **2017**, *143*, 719–730. [CrossRef]
12. Mitchell, D.; Chesnutt, T. *Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports*; California Water Foundation, East Bay Municipal Utility District: Oakland, CA, USA, 2013.
13. Lanzarone, G.; Zanzi, A. Monitoring gas and water consumption through ICTs for improved user awareness. *Inf. Commun. Soc.* **2010**, *13*, 121–135. [CrossRef]
14. Ferraro, P.J.; Miranda, J.J.; Price, M.K. The persistence of treatment effects with norm-based policy instruments: Evidence from a randomized environmental policy experiment. *Am. Econ. Rev.* **2011**, *101*, 318–322. [CrossRef]
15. Torres, J.; Carlsson, F. Direct and spillover effects of a social information campaign on residential water-savings. *J. Environ. Econ. Manag.* **2018**, *92*, 222–243. [CrossRef]
16. Erickson, T.; Podlaseck, M.; Sahu, S.; Dai, J.; Chao, T.; Naphade, M. The Dubuque Water Portal: Evaluation of the Uptake, Use and Impact of Residential Water Consumption Feedback. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012.
17. Corral-Verdugo, V.; Frias-Armenta, M.; Perez-Urias, F.; Orduna-Cabrera, V.; Espinoza-Gallego, N. Residential water consumption, motivation for conserving water and the continuing tragedy of the commons. *Environ. Manag.* **2002**, *320*, 527–535. [CrossRef]
18. Bernedo, M.; Ferraro, P.J.; Price, M. The Persistent Impacts of Norm-Based Messaging and Their Implications for Water Conservation. *J. Consum. Policy* **2014**, *37*, 437–452. [CrossRef]
19. Cialdini, R.; Demaine, L.; Sagarin, B.; Barrett, D.; Rhoads, K.; Winter, P. Managing social norms for persuasive impact. *Soc. Influ.* **2006**, *1*, 3–15. [CrossRef]
20. Schultz, P.W.; Nolan, J.M.; Cialdini, R.B.; Goldstein, N.J.; Griskevicius, V. The constructive, destructive, and reconstructive power of social norm. *Psychol. Sci.* **2007**, *18*, 429–434. [CrossRef]
21. Allcott, H.; Rogers, T. The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation. *Am. Econ. Rev.* **2014**, *104*, 3003–3037. [CrossRef]

22. Taylor, S.; Lobel, M. Social Comparison Activity Under Threat: Downward Evaluation and Upward Contacts. *Psychol. Rev.* **1989**, *96*, 569–575. [CrossRef]
23. Rial, A.; Danezis, G. Privacy-Preserving Smart Metering. In Proceedings of the 10th Annual ACM Workshop on Privacy in the Electronic Society, Chicago, IL, USA, 17–21 October 2011; pp. 49–60.
24. Cuijpers, C.; Koops, B. Smart metering and privacy in Europe: Lessons from the Dutch case. In *European Data Protection: Coming of Age*; Gutwirth, S., Leenes, R.E., de Hert, P., Poullet, Y., Eds.; Springer: Dordrecht, the Netherlands, 2012; pp. 269–293.
25. Liu, A.; Giurco, D.; Mukheibir, P. Motivating metrics for household water-use feedback. *Resour. Conserv. Recycl.* **2015**, *103*, 29–46. [CrossRef]
26. Froehlich, J.; Findlater, L.; Ostergren, M.; Ramanathan, S.; Peterson, J.; Wragg, I.; Larson, E.; Fu, F.; Bai, M.; Patel, S.; et al. The design and evaluation of prototype eco-feedback displays for fixture-level water usage data. In Proceedings of the CHI, Austin, TX, USA, 5–10 May 2012.
27. Sonderlund, A.L.; Smith, J.R.; Hutton, C.; Kapelan, Z. Using smart meters for household water consumption feedback: Knowns and unkowns. *Procedia Eng.* **2014**, *89*, 990–997. [CrossRef]
28. Mehta, R.; Zhu, R. Blue or Red? Exploring the effect of color on cognitive task performances. *Science* **2009**, *323*, 1226–1229. [CrossRef] [PubMed]
29. Thaler, R.; Sunstein, C. *Nudge: Improving Decisions about Health, Wealth, and Happiness*; Yale University Press: New Haven, CT, USA, 2008.
30. Grüne-Yanoff, T.; Hertwig, R. Nudge versus boost: How coherent are policy and theory. *Minds Mach.* **2016**, *26*, 149–183. [CrossRef]
31. Hertwig, R.; Grüne-Yanoff, T. Nudging and boosting: Steering or empowering good decisions. *Perspect. Psychol. Sci.* **2017**, *12*, 973–986. [CrossRef]