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The Impact of Personal Metering in the Management of a Natural Resource Crisis: A Social Dilemma Analysis

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Abstract

A field study and scenario study were conducted to investigate the impact of a structural solution in the management of a natural resource dilemma: The effects of individual metering in a water shortage. It was predicted that metering would be beneficial in promoting conservation, in particular, when people experienced a shortage. Consistent with expectations, the results of both studies revealed that conservation efforts were greater among metered (vs. unmetered) participants when they perceived the water shortage as severe. Additional analyses suggested that the positive effect of metering could be partially explained by a greater concern with the collective costs of overconsumption during the drought. Our findings suggest that structural solutions, such as metering, may produce concomitant effects that extend beyond the outcome structure of the social dilemma.

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Societies around the world are increasingly facing problems involving the availability and distribution of natural resources. In the social psychological literature, these problems are referred to as social dilemmas, because they represent a conflict between the collective interest of society and the individual interests of its members (e.g., Dawes, 1980; Messick & Brewer, 1983). Social dilemmas are most prominent during a resource crisis, such as an immediate water or energy shortage, where unrestrained consumption of some individuals can have devastating effects on the availability of resources for all (Berk et al., 1980). Therefore, it is important to develop an understanding of factors that encourage conservation during such crises.

Social dilemma research has contributed much to our knowledge of conditions under which people are willing to engage voluntarily in the conservation of scarce resources (Samuelson, 1990). Many studies have examined conservation in relation to the prevention of a resource crisis (see Komorita & Parks, 1994; Van Lange, Liebrand, Messick, & Wilke, 1992). Recently, however, there has been increasing attention devoted to studying how individuals behave during a resource shortage (e.g., Kramer, McClintock, & Messick, 1986; Loomis, Samuelson, & Sell, 1995; Messick et al., 1983; Samuelson et al., 1984; Samuelson, 1991). Yet these experimental studies may be limited in generalizability because they have examined resource crises under somewhat artificial laboratory conditions (i.e., with small groups of people sharing points or money as resource pools). Therefore, additional field research is needed to determine if insights derived from experimental social dilemma research can help explain and possibly enhance conservation behavior during natural resource shortages.

For example, previous studies stress the relevance of social psychological factors, such as interpersonal trust and group identity, in the management of a shortage (e.g., Kramer & Brewer, 1984; Messick et al., 1983). In larger dilemmas in society, however, the expectation that a sufficient number of others will voluntarily cooperate generally tends to be low. Accordingly, in real life it may be quite difficult to promote substantial conservation unless conservation is associated with a direct personal incentive (cf. structural goal/expectation theory; Yamagishi, 1986). Structural changes may therefore be needed to foster conservation in the face of an immediate crisis. In this research, we examine the impact of one particular structural solution, individual metering, on conservation decisions in a natural crisis. Based on various social psychological theories of social dilemmas, it is hypothesized that metering is beneficial in promoting conservation, particularly when people are experiencing a shortage. Two studies were conducted to test this prediction in the context of one of the more serious and persistent resource crises in society today: a water shortage (OECD, 1992).

Promoting Water Conservation: Individual and Structural Solutions

The decision to conserve or not can be framed as a social dilemma, which is formally defined by the following properties: (1) Each individual is better off making a self-interested choice (e.g., unrestrained water use) than a pro-social choice (e.g., water conservation), regardless of the decisions of other individuals; and (2) if all (or most) people choose to follow their self-interests, each individual will ultimately be worse off than if all (or most) decide to engage in prosocial behavior (Dawes, 1980). The conflict between self-interest and collective interest is perhaps most salient when society is threatened by an immediate resource crisis, because this situation stresses the need for widespread conservation, but at the same time motivates people to consume as much of the resource while they still can (Kramer et al., 1986).

What strategies could be used to promote conservation during a resource crisis? Consistent with the social dilemma literature (e.g., Messick & Brewer, 1983; Samuelson et al., 1984; Yamagishi, 1986), we distinguish between two general strategies to solve resource dilemma problems. The first strategy aims to promote conservation by bringing about a voluntary change in the behavior of individual consumers, which can be achieved through altering their subjective interpretations of the decision situation. For example, awareness of a water shortage could be increased by media messages stressing the collective need for conservation in terms of public health and hygiene. Interventions based on this individual approach usually consist of education programs, but research evaluating their effectiveness has indicated mixed results (e.g., Berk et al., 1980; Geller, Erickson, & Buttram, 1983; Thompson & Stoutemeyer, 1991).

Greater success can be expected from a structural approach to solving social dilemmas. Structural solutions may be more effective in solving resource dilemma problems because they intervene directly in the outcome structure of the decision situation (Messick & Brewer, 1983; Rusbult & Van Lange, 1996). The primary goal of structural solutions is to reduce or eliminate the inherent conflict between individual and collective interest, thus making conservation (i.e., self-restraint) a more attractive behavioral option. In the context of water resource management, conservation can be promoted, for example, by the implementation of financial incentive programs (e.g., tax deductions for small-scale consumers, or tax increases for bulk consumers), the development of legal restrictions (e.g., hose pipe bans), and by the adoption of water-saving technologies. An example of a conservation-enhancing technological device is the installation of meters for recording domestic resource use (e.g., water, electricity or gas).

The introduction of meters makes it possible to charge consumers on the basis of their personal use level instead of charging a standard fee which is independent of actual use. Water meters have been installed routinely in properties in the US and Western Europe from the 1960s onwards. In the UK, however -- the country where we conducted our studies -- only 10% of dwellings are currently equipped with a water meter. Most customers in the UK pay according to a flat rate tariff, the exact amount of which depends upon the property value and number of household members (OFWAT, 1996).

The present investigation of the effects of metering extends and complements previous work on structural solutions in two important ways. First, past research has primarily focused on conditions under which people wish to change the dilemma structure (e.g., Messick et al., 1983; Rutte & Wilke, 1985; Samuelson et al., 1984; Samuelson & Messick, 1986a, 1986b; Samuelson, 1991), with less consideration for the actual impact of these solutions (for exceptions, see Sato, 1987; Yamagishi, 1986). However, when such changes are implemented in the real world it remains to be seen whether sufficient numbers of people will comply. Previous research indeed reveals that structural interventions that are personally attractive may not succeed if they are perceived as costly, unfair, and infringing on individual freedom (Samuelson, 1993; Van Vugt et al., 1996).

There are also good theoretical reasons to believe that structural solutions may have effects beyond their impact on the outcome structure. Yamagishi's (1986, 1988) research on the structural goal/expectation theory makes this point clear. Using an experimental public goods provision task, he found that low-trust individuals, in comparison to high-trust individuals, initially contributed less money to maintain a public good, but started to contribute at a higher rate when a sanctioning system (i.e., to punish noncooperators) was implemented. This work indicates that structural solutions may indirectly affect cooperation by shaping group members' expectations of others' behavior. The current research extends this line of research by looking at the indirect psychological effects of metering as a structural solution to a real-world social dilemma.

Second, rather than the experimental literature, field research on real-world social dilemmas (e.g., energy conservation, pollution) has devoted greater attention to the effects of structural solutions. Past applied research in this area, however, has not generally been theory-driven and has focused heavily on the impact of monetary incentive programs (e.g., tax benefits, interest subsidies; for overviews of these literatures, see Geller, Winett, & Everett, 1982; Kempton, Darley, & Stern, 1992; Stern, 1992). To our knowledge, few studies have looked at the implementation of conservation-enhancing technologies (Geller et al., 1983; Hankle & Boland, 1971). For example, Hankle and Boland (1971) conducted a longitudinal study to investigate the effects of a large-scale water metering project in an urban area in the US. They obtained an impressive 36% reduction in average demand per year after the introduction of meters, an effect that remained fairly constant over a six year period. Unfortunately, however, this research does not reveal much about the behavioral and psychological factors accounting for the effects of metering, nor does it specify conditions under which these kind of interventions are likely to be most effective. Accordingly, the present research extends previous applied work by examining mediating and moderating variables that might influence the effects of metering (cf. Baron & Kenny, 1986).

How Metering Affects Conservation Decisions

The primary result of metering is that it provides people with a direct (financial) incentive to conserve. In unmetered households, people do not have a personal incentive to conserve as the consumption costs are not determined by their private use but by the average use in their community combined with some characteristics of their property (e.g., property value). Hence, in theory these people can use as much of the resource as they like without incurring additional charges. With the introduction of meters, however, a direct relation is established between use level and costs which is independent from the consumption level in the rest of the community. Thus, it becomes personally attractive for metered households to make efforts to conserve, as this will be noticeable in the size of their bill.

The Impact of Metering During a Resource Crisis

How might the availability of meters affect decisions during a resource shortage? Intuitively, we would expect the effects of metering to be largely independent from other factors in the decision situation because the personal benefits associated with metering (i.e., lower bills for conservation) should remain the same. Theoretically, however, there are at least two good reasons to assume that meters might be especially effective in the face of a resource crisis.

First, the availability of a meter might deter people from engaging in unrestrained consumption when it is most in their self-interest. When resources are abundant there is no direct conflict between the personal interests of individuals and the greater interests of the community, and so the social dilemma is virtually non-existent. Everyone can use as much as they like without affecting others' outcomes, leading to minimal pressures on individuals to restrict their consumption. The social dilemma aspects become highly salient when resources are growing short. Suddenly, there are conflicting pressures brought upon the individual (Kramer et al., 1986; Messick et al., 1983; Samuelson et al., 1984). From a collective viewpoint, the individual should engage in conservation efforts to help with solving the shortage. But, many individuals may decide to increase their consumption rates so as to improve their outcomes before the resource dries up (e.g., by watering their garden or by filling up their swimming pool).

The desire to engage in overconsumption, however, will be attenuated by the presence of a meter because metered households will be "punished" (i.e., by receiving higher bills) if they increase their consumption level in the face of a shortage. Thus, following a purely rational-economic interpretation (Luce & Raiffa, 1957; Messick & Brewer, 1983) we would expect the effects of metering to be more pronounced during a shortage because it will be against people's immediate self-interests to engage in unrestrained consumption.

In addition, there may be other motives accounting for the effects of metering that depart from people's immediate interests. Indeed, the above interpretation assumes that metering is effective only because it protects against overconsumption. We believe, however, that this instrumental perspective is too narrow and that there may be side-benefits to metering that make this intervention particularly effective during a collective crisis. Following notions derived from interdependence theory (Kelley & Thibaut, 1978), we propose that the introduction of meters may give rise to transformation of motivation, a process whereby people forego their immediate outcomes and respond to the broader implications of their decisions. These transformations may be dictated, for example, by concerns with the welfare of the community as a whole or by the motivation to set a good example to other community members (Rusbult & Van Lange, 1996).

The introduction of widespread metering (and the associated change in tariff system) might evoke these prosocial transformations because this intervention conveys to people that they are consuming a resource that is valuable but limited, and should therefore not be wasted (cf. Van Vugt et al., 1996). Also, the presence of a meter gives people a sense of control over their consumption patterns, thereby enhancing the feeling that their decision to conserve might "make a difference" in preserving a resource (see Kerr, 1996). This transformational process is most likely to come about during a shortage because this situation highlights the need for immediate action. Conversely, when there are no resource problems, these prosocial transformations are less likely to be evoked, and they should therefore have little impact on consumption decisions.

Summary of Hypotheses

The preceding analysis leads to the following set of hypotheses regarding the effects of metering during a resource shortage. First, we expect an overall difference in conservation decisions between participants from metered and unmetered households regardless of the severity of the resource state. Because metered households receive larger personal benefits from conservation than unmetered households, we predict first that participants from metered rather than unmetered households will exhibit greater conservation (Hypothesis 1).

Second, we expect behavioral differences as a function of individual perceptions about the severity of the resource shortage. Not all individuals in a community may be equally aware of a shortage, and this differential knowledge may have an impact on their conservation decisions. When individuals perceive the shortage as mild, they presumably will not be motivated to engage in conservation. Conversely, people who perceive the resource shortage as severe are more inclined to conserve so as to cope with the situation (cf. Messick et al., 1983; Samuelson et al., 1984). Accordingly, we predict that regardless of the actual status of the common resource, conservation will be greater to the extent that people perceive the shortage as more severe (Hypothesis 2).

Our third and most important hypothesis predicts an interaction between metering and the severity of the shortage. Out of a concern with either self-interest or the collective interest we argue that people will be more sensitive to metering in the face of a shortage. Thus, we predict that conservation differences between participants from metered and unmetered households will be less pronounced when the water shortage is perceived as low in severity, but more pronounced when the shortage is perceived as high in severity (Hypothesis 3).

Finally, we examine some of the psychological mechanisms underlying the predicted positive effect of metering during a resource crisis. As argued previously, the facilitating role of metering in coping with a shortage may be due to a concern with the personal costs of overconsumption (i.e., higher bills) and/or the collective costs of overconsumption (i.e., resource depletion). Hence, we offer two additional, mutually non-exclusive hypotheses regarding the psychological processes involved in the predicted positive impact of metering during a shortage. We hypothesize that the positive impact of metering in a shortage may be attributed to either a greater concern among metered individuals with the personal costs (Hypothesis 4a) and/or the collective costs of overconsumption (Hypothesis 4b).

Study 1

Study 1 was designed to test Hypotheses 1 through 4 using a sample of participants facing a naturally occurring resource crisis: The 1995 UK water shortage.

Method

Research setting. This study was conducted in the United Kingdom in the summer of 1995. Due to long periods of hot weather and minimal rainfall (e.g., August 1995 recorded only 1 mm rainfall), the UK faced one of its most severe water shortages of the century. Throughout the country, residents were urged via messages from their local water companies to use water wisely and to engage in personal restraint. Suggestions were provided how to decrease domestic water use, particularly advising people to stop watering their gardens. In some regions in the UK, actual bans were imposed on the use of garden hoses and sprinklers.

However, there were no formal restrictions in the area of our research, the county of Hampshire in the South of England.

As in most regions in the UK, the vast majority of dwellings in Hampshire are not equipped with a water meter (i.e., only 8% of the properties are metered). Water companies throughout the UK (i.e., 29 in total) are starting to install meters routinely in newly built houses, but at the moment meters are provided only upon special request and customers will have to pay the installation costs. Consequently, in most areas in the UK it is quite difficult to draw a valid comparison between metered and unmetered households, because they tend to differ in a number of other important respects (e.g., income, household size, conservation attitudes). Our region of interest, however, was particularly suitable for our research because in one part of Hampshire all households were equipped with a water meter following the national metering trials, which were conducted at different areas in the UK in the early 1990s (i.e., these locations were chosen because they were quite representative in terms of climate and types of housing). Hence, by contrasting conservation decisions made in this area with those in made in a similar, but largely unmetered neighboring district, we could assess the effects of metering largely independent of socio-economic differences. Moreover, because all households in Hampshire are served by the same water company, we assumed that these two communities faced identical resource conditions. Although at the time of our research (i.e., September, 1995), the immediate water shortage had been allayed, it was still having a major impact on everyday life, as evidenced by numerous reports that appeared in newspapers and on radio and television.

Participants, design and procedure. Questionnaires were administered to 120 residents in the Hampshire region. Half of the questionnaires ($N = 60$) were distributed in an area where nearly all dwellings were unmetered (i.e., city of Southampton) and the other half ($N = 60$) in an all-metered area (i.e., the Isle of Wight). The samples were drawn from people attending a supermarket in either one of these places on two consecutive Saturday mornings. We did not focus on a particular group of participants, but approached approximately every tenth person leaving the supermarket. Only adults were chosen. Upon leaving the supermarket, they were approached by one of our research assistants, asking them if they were local residents and managed their own household. About seven in ten people agreed to participate and they received an envelope with a questionnaire to fill out at their leisure (i.e., a self-paced procedure). A stamped self-addressed return envelope was included.

Of 120 questionnaires distributed, 80 complete surveys were returned (44 and 36 in the unmetered and metered samples, respectively), yielding an overall response rate of 66.7 percent (i.e., 46.9% by taking into account the people who refused to participate in the first place). Because four residents in the unmetered sample indicated on the questionnaire that their households were in fact equipped with a water meter, their responses were excluded from further analyses. Accordingly, the final sample consisted of 40 participants living in unmetered dwellings and 36 participants living in metered dwellings (32 men and 44 women; mean age = 43 years, SD = 11 years).

Preliminary analyses revealed no systematic differences between the two samples in terms of gender or age, although the average age in the metered sample was slightly higher (Ms = 43.5 and 42.5 years, respectively). Moreover, the average household size was quite similar between the samples (i.e., between 2 and 3 individuals per household), and was comparable to the national average -- household size is generally a good predictor of water consumption rates (Thompson & Stoutemeyer, 1991). The only systematic difference between the samples was that in the metered sample all participants (vs. none in the unmetered sample) were aware of their average water consumption level over the past summer -- this amount is indicated on the water bills.[1]

Conservation questionnaire. The questionnaire consisted of five sections. In the introductory section, it was stated that the research concerned people's perceptions of and decisions during the past summer's water shortage. It was further explained that all answers would be treated anonymously and that a stamped return envelope was included for returning the questionnaire. The second section contained a set of biographical questions (e.g., age, gender, residential area, household size), including a question regarding the availability of a water meter. In the third section, people were asked about their perception of the severity of the water shortage during the summer. The fourth section contained questions regarding people's concerns about the personal and collective consequences of unrestrained water consumption. The final section addressed the conservation decisions of individuals during the shortage. All responses were provided using five-point Likert-type scales (1 = strongly disagree, 5 = strongly agree).

Dependent measures. The following items were used to measure each of the above constructs.

Severity of water shortage. Three items measured perceptions of the severity of the water shortage, adopted from Tyler & Degoey (1995): (1) "The water shortage had an important impact on me and other members of my household."; (2) "The water shortage had an important impact on the people living in my community."; and (3) "The water shortage had an important impact on people all over the UK." The scores on these items were averaged to create one severity scale (alpha = 0.72).

Personal costs of overconsumption. Concern with the personal costs of unrestrained consumption was measured by the following item: "I remained reluctant to splash out because of the fear for large bills."[2]

Collective costs of overconsumption. Collective concern was measured with four items tapping different sorts of concern with resource preservation: (1) "I was willing to exercise restraint, because I felt personally concerned about the water shortage"; (2) "I felt that if I did not limit my water use, this might have collective consequences"; (3) "I did not need to be asked by the water company to conserve, because of the shortage I would have reduced it anyway"; and (4) "During the drought, I sought information how to use water wisely and how to conserve." These items were combined to produce a scale of sufficient reliability (alpha = 0.72). The four item scores were averaged into a single collective concern scale, which correlated moderately with the severity scale ($r = 0.36$, $p < .10$), and was unrelated to the personal concern scale (r = .02, n.s.).

Conservation decisions. Finally, participants were asked to rate the following ten statements concerning their personal restraint during the water shortage (1 = strongly disagree, 5 = strongly agree): (1) "I took fewer baths or reduced the amount of water in the bath"; (2) "I stopped taking baths and had showers instead"; (3) "I only used the washing machine when I had a full load"; (4) "I only used the dishwasher when I had a full load"; (5) "I washed my car less than usual"; (6) "I turned off the tap, while I cleaned my teeth"; (7) "I stopped using the sprinkler and/or hose pipe"; (8) "I watered my garden everyday" (reverse coded); (9) "I watered my garden only at night"; (10) "I used my waste water to water the garden." Because not all questions were relevant to each individual household (e.g., no car ownership), there were varying numbers of "not applicable" responses.[3] Hence, to establish the reliability of the conservation scale, only the participants who rated all ten statements were included in the analysis (N = 56). This procedure resulted in a conservation scale with acceptable reliability (alpha = 0.75). To establish a comparable conservation index across all participants, an average conservation rating was created per individual by dividing the sum of the item scores by the number of responded items (minimum score was 1.0 and maximum score was 5.0).

Water consumption records. In addition to the questionnaire study, we examined the aggregated water consumption records obtained for residents from the metered and unmetered areas in the period in which the shortage occurred (i.e., summer 1995).

Results and Discussion

Conservation decisions: Tests of hypotheses 1-3. A hierarchical regression analysis was conducted to test the predicted effects of metering (Hypothesis 1), severity perceptions (Hypothesis 2), and the combination of these two factors on conservation decisions during the shortage (Hypothesis 3). Before conducting this analysis, the responses to the metering question ("Is the water consumption in your household 1 = metered 2 = unmetered?") were dummy coded to contrast metered (1) with unmetered participants (0). In addition, we centered the scores of the severity scale to eliminate any spurious correlations between this predictor and its interaction with the metering variable.[4]

In a preliminary overall analysis we included various demographic factors (age, gender, and household size) as predictors in our model. Because none of these demographic variables significantly affected conservation decisions, and our hypotheses did not make any predictions regarding their effects, these variables were not included in further analyses.

Hence, in a second regression analysis we entered the two main factors (i.e., metering, severity) in the equation first, followed in the second step by the interaction between these factors. The total variance explained by these three effects was approximately 30% (Adjusted $R^2 = .2967$). More than 19% of the total variance could be attributed to the two main factors (Adjusted $R_2 = .1944$, $F[2,73] = 10.05$, $p < .001$), and an additional 10% to their interaction (R^2 change = .1023, $F(3,72) = 11.54$, $p < .001$).

In Hypothesis 1, we predicted that participants from metered households would exhibit greater conservation overall than participants from unmetered households. This hypothesis was not confirmed. Metering did not contribute significantly to predicting people's conservation decisions (beta =0.09, $p = .22$), although in line with our prediction, the sign of the beta-weight indicated a positive relation between metering and conservation (this will be addressed in the general discussion).

Our second hypothesis was that people would exhibit greater conservation during the shortage when the shortage was perceived as more severe. Consistent with that hypothesis, a positive relationship was observed between perceived severity and conservation (beta =0.47, $p < .001$), indicating that conservation was greater among participants who perceived the water shortage as more severe.

Our most important hypothesis predicted an interaction between metering and severity such that conservation differences between metered and unmetered households were more pronounced when the water shortage was perceived as more severe. As indicated earlier, the interaction between these factors contributed significantly to explaining conservation decisions in our sample (beta =0.44, $p < .001$), adding more than 10% to the total sum of explained variance.

A graphic display of the relation between metering and severity is presented in Figure 1. We used a standard procedure for examining interactions involving continuous variables as described by Aiken and West (1991). This procedure involved calculating simple regression lines at specific high and low values of the standardized severity scale, which can then be depicted in a line graph. The values correspond to one standard deviation below and above the average severity score ($SD = 0.86$). Figure 1 shows that metered participants reported greater conservation than unmetered participants when the shortage was perceived as mild; however, differences between the two groups were much more pronounced when the shortage was perceived as severe.

Another way to examine this interaction is by looking at the regression slopes for the metered and unmetered group, separately. Consistent with Hypothesis 3, it was found that the regression slope differed significantly from zero only for the metered sample, $t(39) = 2.37$, $p < .05$. These tests provide further support for the hypothesis that conservation differences between metered and unmetered participants are significantly greater when the water shortage seemed highly severe (Hypothesis 3).

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Insert Figure 1 about here.

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Personal concerns and collective concerns as mediators of the impact of metering: Tests of hypotheses 4a and 4b. Hypothesis 4 predicted that the conservation enhancing effect of metering during a shortage (i.e., the obtained interaction between metering and severity) might be attributed to a greater concern with the personal costs (Hypothesis 4a) and/or collective costs (Hypothesis 4b) of resource overconsumption. To test the mediational roles of personal and collective cost concerns, we performed several additional analyses. To establish mediation, we first had to demonstrate a link between the mediator and the presumed causal factor, the interaction between metering and severity (Baron & Kenny, 1986). Hence, we performed two separate analyses in which we regressed, respectively, personal and collective cost concerns onto the two main factors (i.e., metering, severity) and their interaction. First, the analysis for personal concern revealed significant main effects for both metering (beta =0.53, $p < .001$), and severity (beta =-0.34, $p < .05$). This analysis also revealed a significant interaction effect between metering and severity (beta =0.43, $p < .01$). The total variance explained by the three predictors in the model was 34%, $F(3,72) = 62.92$, $p < .001$.

In Figure 2, the interaction between metering and severity for personal cost concerns is displayed in a line graph, using the Aiken and West (1991) procedure. Figure 2 reveals that the differences between metered and unmetered participants were much larger when the shortage seemed highly severe. The individual regression slopes indicated that metered participants became more concerned with the personal costs of overconsumption as the shortage seemed more severe, $t(39) = 2.18$, $p < .05$. Interestingly, we found a reverse pattern among unmetered participants, who reported a significantly weaker concern with the personal costs of overconsumption as the shortage seemed more severe, $t(31) = -2.05$, $p < .05$.

In a second regression analysis, we regressed collective cost concerns onto the same three factors (metering, severity, and interaction). This analysis yielded significant effects for severity (beta =0.57, $p < .001$), and for the interaction between metering and severity (beta =0.15, $p < .05$). The total variance explained was 30%, $F(3,72) = 11.83$, $p < .001$.

Figure 3 illustrates the interaction effect of metering and severity on concern with collective costs. When the severity of the shortage seemed low, both metered and unmetered households were relatively unconcerned about the collective consequences of their consumption. But, when the shortage seemed to be severe, metered participants were more concerned than unmetered participants. Indeed, further testing revealed that the regression slope for the metered sample differed significantly from zero, $t(39) = 2.71$, $p < .01$, whereas the slope for the unmetered sample was not significant.

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Insert Figures 2 and 3 about here.

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The results in Figures 2 and 3 indicated that metered participants were more concerned than unmetered participants with both the personal costs and the collective costs of overconsumption, but only when the shortage seemed highly severe. These results suggest that both personal and collective cost concerns may be involved in explaining the positive effects of metering on conservation when people are experiencing a shortage. However, to establish mediation conclusively, we also had to show that personal and/or collective cost concerns indeed affected individual conservation decisions. Moreover, when the impact of either one of these concerns was accounted for, the obtained interaction between metering and severity should have disappeared or decreased substantially (Baron & Kenny, 1986).

To address these issues, we performed an additional hierarchical regression analysis using conservation as the criterion variable, with metering, severity, and both personal and collective concerns as predictors in the first step, along with the Metering x Severity interaction in the second step. In combination, the four main factors entered in the first step accounted for 41% of the explained variance in conservation decisions, $F(4,71) = 10.42$, $p < .001$. Hence, by adding these psychological variables to the regression model, the total variance explained increased substantially by more than 11%. In contrast to our predictions, however, the interaction between metering and severity remained statistically significant (beta =0.34, $p < .01$), even after adding personal and collective concerns to the model. There was thus no evidence for complete mediation, but the variance accounted for by the Metering x Severity interaction did decrease substantially from 10% in the original equation to approximately 6% when these concerns were added as predictors. Which of the psychological processes accounted for the decline in the impact of the interaction on conservation decisions? Contrary to Hypothesis 4a, the analysis revealed no significant link between conservation and personal concern (beta =0.18, $p = .15$). Hence, there was no evidence that people engaged in greater conservation during a shortage because they were more concerned about the personal costs of overconsumption. The regression did reveal, however, a significant positive link between conservation and collective concern (beta =0.51, $p < .001$), indicating that people conserved more to the extent that they were more concerned with the preservation of the scarce resource (Hypothesis 4b). Accordingly, the positive impact of metering during a shortage was, at least partially, mediated by a greater concern with the collective (rather than personal) costs of engaging in unrestrained consumption.

Water consumption records. In an exploratory vein of this study, we also examined the aggregated monthly water consumption records for both the metered (i.e., Isle of Wight) and unmetered areas (i.e, city of Southampton) during the summer period of 1995 in which the shortage occurred. Because there were no specific consumption records available for Southampton, we used the monthly water consumption rates from the region in which Southampton is located (i.e., Hampshire county), which consists almost exclusively of unmetered properties.

One way to examine these data is to look at the growth rate in water consumption in the summer period of 1995 compared to the same period in the previous year in which there were no resource problems. Ideally, we would expect to find a different growth percentage for the metered and unmetered communities in this particular period.[5] To examine this, the monthly records for both communities were grouped into three periods of four months each: Presummer (January through April), summer (May through August), and postsummer (September through December). Subsequently, we subjected the monthly growth rates (from 1994 to 1995) to an ANOVA with a 2 (Area: Metered vs. Unmetered) by 3 (Season: Presummer, summer, postsummer) factorial design.

Despite the small number of data points (i.e., 24 percentage scores), this analysis revealed some interesting results. First, a main effect was obtained for season, $F(2,18) = 12.44$, $p <.001$, which indicated a strong growth in water consumption in the summer period of 1995 (i.e., a 9.5% increase compared to the previous year), and this growth rate was weaker in the presummer period (M = 2.5%) and absent in the postsummer period (M = -0.9%).

The results further indicated that the growth rates in these periods were not equivalent for the two communities, although the interaction effect between Area and Season was only marginally significant, $F(2,18) = 2.66$, $p < .10$. The growth percentages, displayed in Figure 4, suggest that the biggest difference between the metered and unmetered areas was found in the period in which the shortage occurred (i.e., the summer season), which is in line with our prediction. During the summer of 1995 the water consumption in the unmetered area rose by 12.3% compared to 6.8% in the metered community ($p <.05$). In the presummer and postsummer periods the differences in use levels for the unmetered and metered areas were much smaller (presummer: respective M's = 0.8% vs. 4.3%; postsummer: respective M's = -2.1% vs. 0.3%, n.s). Inspection of the monthly figures revealed that the differential growth rates for the metered and unmetered areas could be largely attributed to usage differences in August, at which time the drought was at its worst, and water demands in the unmetered area rose by more than 16% versus just over 6% in the metered area.

Regardless of the inherent difficulties in using these aggregate data to validate conclusions from our small scale survey, the above findings further support our claim that the beneficial effects of metering are indeed most pronounced during the period of a shortage. It is interesting, however, to note a discrepancy between these data and the findings of the survey. Extrapolating from the consumption records we would expect metered residents to indicate overall greater conservation than unmetered residents. However, the survey results reveal this is only true for residents who perceive there is a shortage (this will be addressed in the general discussion).

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Insert Figure 4 about here.

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Study 2

Study 2 was conducted to extend and complement our first study by examining the relationship between metering, severity, and conservation decisions within the framework of a scenario study. This approach allows us to draw stronger conclusions about the nature and direction of relationships in the model than would be justified on the basis of the cross-sectional survey data of Study 1 alone. For example, did perceived severity of the shortage influence decisions to conserve or was it the other way around so that these perceptions merely served to justify conservation?

Given our focus on studying resource dilemmas in a natural context, we considered it more appropriate to use a scenario paradigm rather than laboratory paradigm (e.g., experimental resource task; Messick et al., 1983) to replicate the survey findings. Although a laboratory approach would perhaps provide a more rigorous experimental test of our findings, the scenario approach would enable us to simulate a resource shortage on a natural scale with realistic behavioral options (i.e., to conserve water) and outcomes (i.e., being charged for water) adding to the ecological validity of our findings (Cooper, 1976). Hence, life-like scenarios were created which provided residents with information regarding (a) the severity of the water shortage in their community, and (b) the availablity of a water meter in their household. These scenarios provided a suitable framework for retesting the primary hypotheses of Study 1 (i.e., the main effects of metering, severity, and the interaction; hypotheses 1 through 3).[6]

Method

Participants and design. Sixty-four individuals (24 men, 39 women, and one person who failed to indicate gender) participated in the second study, which was conducted in September 1996 -- almost one year after Study 1. On average, these participants were nearly 45 years old (SD = 15 years), and were sharing a household of 2.5 people on average. These sample characteristics are similar to those of Study 1. The vast majority of participants in Study 2 resided in dwellings without a water meter (95.7%). None of the participants could indicate their water consumption during the preceding months (May, June, July, August). To test our hypotheses, scenarios were developed according to a 2 (Metering: Metered vs. Unmetered Water Use) by 2 (Severity of Shortage: Low vs. High) experimental design, with the first variable manipulated within and the second variable between participants. Participants were randomly allocated to either one of the severity conditions.

Procedure. One hundred participants were approached at two different locations in Southampton, a middle-sized city in Southern England. Approximately half of the participants were recruited at a large shopping mall and the other half at a parking area in the vicinity of the local university on different weekdays. Of the 100 questionnaires distributed at these two locations, 64 in total were returned. There were no apparent differences between these two samples in terms of response rate, age, gender, or household composition.

Although we did not focus on specific groups of participants, we tried to avoid approaching people who were unlikely to run their own households (e.g., teenagers, students) because these individuals would presumably not have to pay for their own water use. Participants were approached by a research assistant and asked if they would be willing to participate in a study regarding preferences for different domestic water use tariff systems. After they expressed their willingness to participate, they received an envelope containing an introduction letter, a questionnaire, and a freepost envelope. The introduction letter stated that the questionnaire could be completed at their leisure and that responses would be completely anonymous. Moreover, upon request, a summary of the research findings would be mailed to them.

Biographical questions. In the first part of the questionnaire, we asked participants to fill out questions regarding gender, age, residential area, household size, and the availability of a water meter.

Scenarios. The second part of the questionnaire consisted of different scenarios in which information was provided regarding the state of the water resources in some part of the UK where the participants were supposedly living. These scenarios were introduced as follows:

"Life on earth would be impossible without water. It is essential for mankind to have sufficient water supplies year round. Under normal circumstances there is enough water in the UK to meet the demands of all citizens. Currently, however, parts of the UK are confronting water shortages. Shortages, such as these, now and then occur due to sudden droughts, leakages in distribution systems, or massive demands."

Subsequently, specific information was given about the resource conditions in the area where the participant was (supposedly) living.

Severity of water shortage. Half of the participants were asked to imagine they were living in a region where water shortages were relatively uncommon and insignificant:

"Suppose you are living in an area where there are usually no problems with the availability and distribution of water. The supply of water is nearly always sufficient to meet the demands of all the customers in the area (low severity condition)."

The other half received information that water shortages were relatively common and severe in their region:

"Suppose you are living in an area where there are frequent and serious problems in the availability and distribution of water. The supply of water is regularly insufficient to meet the demands of all customers in the area (high severity condition)."

Availability of water meters. Each participant received information about two different systems of water charges in the region in which he or she was (supposedly) living. First, in the Metered condition, it was stated that all dwellings in their area were equipped with water meters. Hence, the water charges for the households would be based on personal consumption levels. Accordingly, households that consumed more (less) water would have to pay more (less). In the Unmetered condition, participants were told that none of the dwellings in the region were equipped with meters. Water charges would be based on a flat rate tariff system, which implied that people would pay the same amount of money as everybody else, regardless of their private consumption rate. Hence, people could use more (less) water without having to pay more (less).

The sequence in which participants received these two conditions was counterbalanced to control for possible effects of the order in which they were read.

Conservation intention. After each scenario was read, participants were asked to indicate their willingness to conserve domestic water under the given circumstances. Conservation decisions were assessed using both a general and more specific intention measure: (1) "Are you willing to conserve water in your household?", and (2) "Would you be willing to take fewer baths or showers?" (1 = not at all, 7 = very much so). These items correlated substantially ($r = 0.58$), which allowed us to create a single conservation index by averaging the scores on these questions.

Manipulation check. To provide a check on our manipulation of the severity of the shortage, participants were asked to rate the following question: "How severe do you consider the situation regarding the water resources in the scenarios you have just read?" (1 = not at all severe, 7 = very severe). Analysis of responses to this item indicated that the severity manipulation was successful in that participants in the high severity condition reported the situation as more severe ($M = 4.94$, $SD = 1.41$) than participants in the low severity condition ($M = 3.70$, $SD = 1.76$), $F(1,62) = 9.84$, $p < .01$.

Results and Discussion

We performed a 2 (Metering: Metered vs. Unmetered Water Use) by 2 (Severity of Resource Shortage: Low vs. High) by 2 (Order: First Metered vs. First Unmetered) repeated measures ANOVA with the first variable serving as within participant factor. Because this initial analysis yielded no order effects, we collapsed the experimental design across the different order conditions for all further analyses.

Consistent with the first hypothesis, our analysis revealed a strong main effect for metering, $F(1,62) = 15.70$, $p < .001$. Although overall there was not a great willingness to conserve ($M = 3.76$; significantly below the scale midpoint), the results revealed greater conservation when water use was metered ($M = 3.97$; $SD = 1.63$) rather than unmetered ($M =$

3.36; SD = 1.60).

A strong main effect for severity was also observed, $F(1,62) = 15.86$, $p < .001$, revealing that participants were more willing to conserve in the high severity condition (M = 4.41, SD = 1.83) rather than in the low severity condition (M = 2.91, SD = 1.40). This finding is consistent with Hypothesis 2.

Most importantly, the ANOVA also revealed a significant interaction between metering and severity, $F(1,62) = 3.66$, $p < .05$. The means associated with these effects are displayed in Figure 5. When the shortage was perceived as severe, individuals reported greater willingness to conserve in the Metered condition (M = 4.84, SD = 1.74) than in the Unmetered condition (M = 3.98, SD = 1.91), $t(31) = 3.14$, $p < .01$. However, when the shortage was not perceived as severe, the difference in conservation between Metered (M = 3.09, SD = 1.51) and Unmetered conditions (M = 2.73, SD = 1.29) was much smaller, and only marginally significant, $t(31) = 1.55$, $p < .10$.

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Insert Figure 5 about here.

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In summary, the findings from Study 2 provided clear support for all three hypotheses. First, willingness to conserve was greater when water use was known to be metered rather than unmetered. Second, willingness to conserve was higher when the water shortage was perceived as severe rather than mild. Finally, differences in conservation between the metered and unmetered scenario conditions were greater when the water shortage seemed severe rather than mild (Hypothesis 3).

General Discussion

The primary goal of our research was to examine the impact of metering on beliefs and conservation decisions during a naturally occurring resource crisis -- a water shortage. A survey and scenario study were reported to test the main hypotheses. The first hypothesis predicted an overall positive effect of metering on conservation, but this effect was only significant in the scenario study. Both studies revealed a link between the perceived severity of the shortage and conservation decisions, supporting the second hypothesis. Finally, both studies provided good evidence that the effects of meters were most pronounced during a perceived shortage.

Our most important finding was the interaction between metering and severity, obtained in both the field and scenario study. When the shortage seemed to be mild, there were relatively small differences in conservation efforts between people who were metered versus unmetered. However, when the shortage was perceived as severe, metered participants showed much greater restraint. These results are relevant because they delineate that natural resource crises, such as water or energy shortages, could be managed better by the widespread provision of domestic use meters. Scientists are generally quite pessimistic about the success of interventions to promote voluntary conservation during shortages, because these situations highlight the conflict between short-term personal interests -- to consume as much of a resource as possible -- and the long-term interest of the community -- to exercise restraint (e.g., Hardin, 1968; Kramer et al., 1986). The current research suggests that this conflict of interests, which is inherent to the social dilemma nature of resource problems, can be reduced by the installation of a relatively simple and cost-efficient technological device, a domestic use meter.

What psychological mechanisms account for the beneficial effects of meters in coping with a shortage? In the introduction, we offered two mutually non-exclusive explanations based upon either a concern with immediate self-interest or with long-term collective interests. Following a rational-economic model (e.g., Luce & Raiffa, 1957; Messick & Brewer, 1983), metering was thought to be effective because it would temper the desire to overconsume for fear of a high water bill (Hypothesis 4a). Alternatively, following notions derived from interdependence theory (Kelley & Thibaut, 1978) metering was thought to be effective because metered customers would be more concerned about resource preservation (Hypothesis 4b).

The mediational analyses in Study 1 provided some support for a prosocial interpretation of the effects of metering. The results of the regression analyses showed that the effects of metering could be attributed, at least in part, to a greater concern among metered participants with the collective costs of overconsumption (i.e., fear of resource depletion). Moreover, by partialling out the impact of collective concerns, the interaction effect of metering and severity on conservation was attenuated. Hence, it seems that the presence of a water meter encourages people to engage in conservation, particularly when it is collectively most desirable (cf. "transformation of motivation"; Kelley & Thibaut, 1978).

The claim that the positive effects of metering during a shortage are motivated by self-interest (as would be predicted by classic social dilemma theories) is less evident from the present findings. In support of this claim, metered participants reported to be more concerned with the financial implications of water use during the shortage, whereas people in the unmetered sample expressed an even weaker concern with the financial impact of water use. Yet, there was no evidence that these concerns actually influenced conservation decisions (i.e., no evidence for mediation). We admit, however, that this may be due to methodological problems, because the personal cost concerns were measured by a single item index, which is inherently less reliable.

Indeed, at least partial support for a self-interested interpretation flows from the aggregated water consumption records collected within the two communities. These records show a dramatic 12% increase in use for the unmetered population during the summer of 1995 in which the shortage occurred (i.e., compared to the same period in the previous summer). Although the rise in water use was much less pronounced in the metered community, this area still showed a 6% increase in water consumption during the same period. This suggests that people in metered dwellings were perhaps also tempted to use more water during the shortage. However, unlike people in unmetered dwellings, their desire may have been inhibited by the fear to incur higher charges. These findings should, however, be interpreted with some caution because they are based upon population data rather than sample data and could therefore be interpreted in many different ways. For example, regardless of whether people make conscious conservation efforts, during hot summers water demands will automatically rise (Hankle & Boland, 1971).

Moreover, we acknowledge that beyond the importance of personal and collective costs there may be various other explanations for the positive effects of metering in a shortage. For example, it is quite conceivable that metered households coped better because they felt their contribution could make a real difference in tackling the shortage (cf. personal efficacy; Bandura, 1977; Kerr, 1996). Because they receive regular feedback about their consumption patterns on their water bill, people in metered households probably know better what individual actions are most effective in coping with a water shortage and therefore may respond better to a crisis (cf. Seligman & Darley, 1977). Alternatively, it is possible that people in metered communities cope better because they have greater confidence in the conservation efforts of other community members. As indicated in the social dilemma literature (Pruitt & Kimmel; 1977), people are more likely to cooperate if they expect their actions will not be exploited by "selfish" others. The widespread introduction of meters may help to build this trust because people will realize that everyone else in their community also has a good (financial) reason to exercise restraint (cf. Yamagishi, 1986).

From a more theoretical perspective, the presented findings are important because they contribute to further thinking about the distinction between individual and structural solutions to social dilemmas. In contrast to individual solutions, structural solutions have traditionally been expected to exert their primary influence on behavior through a direct change in the pay off or outcome structure of the social dilemma (Messick & Brewer, 1983; Rusbult & Van Lange, 1996; Yamagishi, 1986). The current research suggests, however, that structural solutions may produce concomitant effects that extend beyond the immediate outcome structure. The finding that metering enhanced residents' concerns about the collective consequences of overconsumption demonstrates indeed that structural solutions can have indirect effects in social dilemmas by changing the value people attach to a particular resource or good.

This result is theoretically significant because it underscores the reciprocal nature of the relationship between individual and structural solutions (Samuelson & Messick, 1995; Yamagishi, 1986). Yamagishi's (1986, 1988) research on sanctioning systems has clearly shown the interrelationship between these two approaches by demonstrating that individual solutions affect the preference for structural solutions, and that these structural solutions, in turn, influence the way people perceive and interpret the dilemma. Our results further support this view and point to the need for a more complex analysis of the effects of individual and structural solutions.

In this sense, the present findings can be interpreted as providing field data consistent with Yamagishi's (1986) structural goal/expectation theory by showing that structural solutions, in addition to their direct effect on people's outcomes, may have indirect psychological effects similar to those of individual solutions. The traditional dichotomy between individual and structural solutions (Messick & Brewer, 1983) may have been useful for heuristic purposes, but the accumulated data now indicate that it is time to move beyond this simplified taxonomy to investigate the dynamic interrelationship between structural changes and individual's psychological and behavioral responses within their new interdependence structure. Interdependence theory (Kelley & Thibaut, 1978) offers a promising conceptual framework to understand these dynamics by emphasizing that structural solutions may have broader implications than changing people's immediate outcomes (i.e., transformation of motivation).

From a practical viewpoint, the psychological side-benefits of structural change are quite important, because in real world dilemmas there are usually very few incentives associated with conservation. It is socially unacceptable to increase the financial costs of water use considerably and therefore one needs to rely on additional psychological effects to make a slight change in the reward structure effective in promoting conservation. These indirect consequences are perhaps even more important in maintaining a behavioral change.

Because most structural solutions are temporary (e.g., monetary incentive programs), there is a danger that people will revert back to their old habits once the incentives have been removed. This does not always seem to happen though (e.g., Kempton, Darley, & Stern, 1992), which may be explained by the fact that structural solutions produce effects beyond the direct outcome structure.

Our focus on structural change in a natural resource crisis clearly departs from previous approaches to study social dilemmas. Much of our existing knowledge about resource dilemmas and structural change is based upon small-scale laboratory studies (e.g., Messick et al., 1983; Samuelson et al., 1984; Rutte & Wilke, 1985). These studies undoubtedly make a significant contribution to our understanding of when groups opt for structural change (see Samuelson & Messick, 1995). Our research extends this line of research by investigating how people actually respond to structural solutions when they are implemented in the real world (see also, Van Vugt et al., 1996). We believe our approach is ecologically more valid because people often have only limited influence on the kind of structural solutions they desire. Most often, these solutions are imposed by ruling authorities and citizens must simply decide whether to cooperate (cf. Tyler & Degoey, 1995).

Despite the strengths of our research, we should also note certain limitations. One obvious weakness concerns the fact that our findings are largely based upon self-reported data. The results may therefore be influenced to some extent by self-presentation motives. This is perhaps most evident in the discrepancy between the survey data of Study 1 and the aggregated water consumption data obtained for the metered and unmetered areas. Whereas the actual water consumption records showed some differences in how residents from these areas responded to the shortage, the survey findings revealed no such differences in reported conservation. Perhaps the unmetered residents in our sample did not want to admit their lack of restraint during the shortage, and may therefore have decided to inflate their conservation efforts in completing the questionnaire. This interpretation is tentative, however, because the analysis of the water consumption data was not particularly robust (i.e., no sample-specific data).

A second limitation associated with Study 1 is that these findings are based upon a cross-sectional survey which makes it difficult to draw any causal inferences. For example, did people fail to exhibit restraint because they perceived the shortage as mild or did these perceptions merely serve as a justification of their lack of effort? Moreover, because our data were collected after the immediate water shortage was alleviated, respondents may have had difficulties recalling their perceptions and decisions accurately. In this regard, note that the findings from Study 1 were replicated in a second study with a more rigorous research design, in which participants were presented with realistic scenarios about the state of water resources and presence of a water meter. Moreover, our results are quite consistent with findings from experimental research showing that conservation decisions are indeed shaped by the personal and collective benefits associated with these decisions (e.g., Messick et al., 1983; Samuelson et al., 1984).

Directions for Future Research

In light of the above limitations, we propose the following recommendations for further research into structural change in resource dilemmas. First, field research should be conducted to link survey data to individual consumption records rather than aggregated community records. It would be interesting, for example, to carry out a longitudinal study in which an unmetered area is compared with a universally metered area, where part of the households are charged according to use but others pay a standard fee (similar to unmetered households). This would make it possible to examine the long-term impact of domestic water meters and to separate the psychological effects of having a meter from the economic effects of the charging system per se. It may be that the mere presence of a water meter and the associated feedback system is already sufficient to promote conservation (Seligman & Darley, 1977).

Second, laboratory experimentation may be needed to assess which psychological mechanisms may account for the impact of metering (e.g., concern with personal or collective costs). Both the survey and scenario methodology used in our research are not really adequate to determine the influence of mediating factors. To establish their impact, a more rigorous experimental approach may therefore be needed. For example, the experimental resource dilemma task (Messick et al., 1983) could be used to measure the effects of metering (i.e., paying per resource unit) under various resource conditions in the laboratory, whereby the consequences of the harvest decisions for oneself and the group as a whole are varied systematically. This would make it possible to determine if the effects of metering in a shortage are due primarily to a concern with personal outcomes (i.e., fear for charges) or collective outcomes (i.e., fear for resource depletion).

Metering as a Tool for Resource Management

How do our findings contribute to the development of strategies to preserve scarce resources in modern society (e.g., water, gas)? The current findings suggest that metering programs might help to promote resource management in at least two different ways. First, by giving people a personal incentive to conserve, metering might be helpful in preventing a future shortage (cf. Hankle & Boland, 1971). Perhaps more importantly, our results show that this intervention might be particularly beneficial in coping with an acute shortage -- such crises will become increasingly frequent (OECD, 1992; OFWAT, 1996). It is therefore important to think of ways to promote the widespread adoption of meters and other water saving devices (e.g., toilet dams, low flow shower nozzles). Social psychologists have an important role to play in this by developing campaigns to increase the public acceptance of these technologies (Geller et al., 1983; Kempton et al., 1992; Stern, 1992). Based upon the current findings, we suggest that messages to promote meters should accentuate both the benefits for people personally (i.e., lower bills) and those for society as a whole (i.e., resource preservation). Finally, in light of a future water shortage, the current findings suggest that activities to encourage conservation should be targeted primarily at unmetered households because they may lack both the motivation and skills to restrain their use. In metered areas, it may be sufficient just to provide people with information about the severity of the shortage.

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Footnotes

[1] Although the survey did not reveal any great differences in demographic make-up between the samples, it needs to be said that the unmetered sample was drawn from a relatively more urbanized area. We are not sure what the implication of this difference is for our predictions. It must be noted, however, that our primary interest was not to compare the water use levels between the communities as such, but whether there were differences in how these communities responded in the face of a shortage. There are no strong reasons to assume that urbanization would influence such reactions (Schroeder, Penner, Dovidio, & Piliavin, 1995).

[2] The expression "splash out" is a phrase commonly used in the UK to indicate excessive consumptive behavior.

[3] A number of "not applicable" responses were obtained on the following items: "I only used the dishwasher when I had a full load" (N = 56); "I stopped taking baths and had showers instead" (N = 58); "I washed my car less than usual" (N = 69).

[4] Interaction effects calculated with uncentered scores can produce considerable multicollinearity, which may lead to problems in the estimation of regression coefficients (Aiken & West, 1991).

[5] Note that the population sizes in both these areas remained fairly stable from 1994 to 1995. Thus, any growth in water use could not be attributed to an increase in the number of users.

[6] Because the primary goal of Study 1 was to firmly establish a link between metering and conservation, we did not explore possible psychological processes that might account for the predicted effect of metering (e.g., concern with collective or personal costs; Hypotheses 3a and 3b). Moreover, such concerns are likely to be related to frequent exposure to a water meter, and thus would be difficult to investigate within the context of a scenario study.

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Figure Captions

Figure 1. The impact of metering and severity of shortage on conservation in Study 1.

Figure 2. The impact of metering and severity of shortage on concern with personal costs.

Figure 3. The impact of metering and severity of shortage on concern with collective costs.

Figure 4. Relative growth in water use in 1995 as a percentage of 1994 for the metered and unmetered areas.

Note. The water shortage occurred in the summer period of 1995.

Figure 5. The impact of metering and severity of shortage on conservation intentions in Study 2.