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Using individual householder survey responses to predict household environmental outcomes: The cases of recycling and water conservation

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Abstract

Although individuals' self-reports of behaviour are often used as a proxy for household environmental outcomes, little is known about how accurate they are or what factors might moderate accuracy. The current research investigated this question in relation to household recycling and water use. Results of Study 1 showed a significant, albeit weak, relationship between self-reported household recycling and objective measure of recycling that was not moderated by the number of people in the household. There was some evidence though that the relationship between self-reported and objective household recycling was stronger when respondents perceived more supportive community norms for recycling. The results of Study 2 supported Study 1 in showing a significant but weak relationship between self-reported water conservation behaviour and objective household water use that was again not moderated by the number of people in the house. Similar to Study 1, Study 2 showed that there was a stronger relationship between self-reported and objective behaviour when respondents had more favourable attitudes, more supportive subjective norms, and greater self-efficacy in relation to water conservation. Taken together the research suggests that psychological variables that orient householders to environmental behaviour are more important influences on aligning self-reported behaviour with objective outcomes than knowledge about the behaviour of others in the household.

1. Introduction

Households are significant producers of waste and high consumers of resources through their use of energy and water in the home and indirectly through their broader consumption. Households are therefore an important site for waste recovery and conservation. In light of this, the research focus on understanding and promoting household recycling and resource conservation is not surprising. What is surprising though is that where studies have addressed these issues, they often rely on one individual in the household to provide data on behalf of the household. For example, individual householders often respond to surveys that ask about the amount of household waste that is recycled, (e.g., Barr & Gilg, 2005; Hage, Söderholm, & Berglund, 2009; Halvorsen, 2012; López-Mosquera, Lera-López, & Sánchez, 2015; Robinson & Read, 2005; Saphores & Nixon, 2014), or the number of conservation actions performed by household members (Barr, Gilg, & Ford, 2005; Corral-Verdugo, Carrus, Bonnes, Moser, & Sinha, 2008; Sarabia-Sánchez, Rodríguez-Sánchez, & Hyder, 2014). Although this is no doubt due to the difficulty of obtaining responses from multiple householders, it nevertheless raises the critical question of whether and to what extent individual members of a household can represent the collective household experience. Given that 'household' survey responses are not randomly selected from the household (i.e., the most environmentally-interested or time-rich person may respond), the use of individual responses may be far from accurate.

In the current paper we present two studies that address the question of how well individual householders' self-reported behaviour reflects household environmental outcomes. We focus on two important household environmental domains: waste recycling and water conservation. Recycling is a crucial response to rising levels of consumer waste (Hoornweg & Bhada-Tata, 2012) and with water resources placed under increasing pressure in coming decades (Vörösmarty, Green, Salisbury, & Lammers, 2000) water conservation is an essential component to securing long-term water sustainability (Arbués,

Garcia-Valiñas, & Martinez-Espiñeira, 2003). We test the sufficiency of individual household responses by examining the relationship between individuals' self-reports of household recycling and water conservation and objective measures of outcomes in these domains. We also explore whether there are variables that moderate this relationship, for example, the number of people in the household, or psychological factors that may influence the alignment between self-reported behaviour and household outcomes.

1.1 Disparities between self-report and objective measures of behaviour

Previous researchers have drawn attention to the potential disconnection between self-reported and observed behaviour. For example, studies have shown disparities between self-reported and observed recycling and re-use behaviour (Corral-Verdugo, 1997; Corral-Verdugo & Figueredo, 1999; McGuire, 1984; Porter, Leeming, & Dwyer, 1995), water conservation behaviour (Hamilton, 1985) and energy use (Warriner, McDougall, & Claxton, 1984). Recently, Chao and Lam (2011) explored the validity of self-reported environmental behaviour by comparing them with reports of the same behaviour by observers. They showed significant and moderate correlations between self-reported and observer-reported behaviour. Similarly, Corral-Verdugo and Figueredo (1999) also showed low to moderate correlations between self-reports and observations of householders' re-use of glass, clothing and metal. A meta-analysis of the relationship between self-reported and objective measures of pro-environmental behaviour showed a strong and positive relationship between the measures, although the authors also concluded that 79% of the association in the relationship between self-report and objective measures was unexplained (Kormos & Gifford, 2014).

The focus of previous research comparing self-report and objective measures of environmental behaviour, has predominantly been on individuals' behaviour rather than on the relationship between self-reports and household outcomes. Although one might question the appropriateness of using individual's responses as proxies for overall

household behaviour or sentiment, in practice this approach is not uncommon. For example, many studies have relied on the responses of individual householders to examine the predictors of household recycling and resource conservation (e.g., Barr, 2007; Barr & Gilg, 2005; Barr et al., 2005; Hage et al., 2009; Halvorsen, 2012; López-Mosquera et al., 2015; Robinson & Read, 2005; Saphores & Nixon, 2014; Sarabia-Sánchez et al., 2014; Wan, Qiping Shen, & Yu, 2014) and these studies seem to implicitly suggest that the individual is able to provide accurate and meaningful responses on behalf of the household. As noted above though, past studies suggest a mismatch between self-reported and objective behaviour of individuals, with low to moderate correlations at best.

There are at least two reasons why this mismatch may emerge. One reason advanced by researchers is that self-reports reflect a different perceptual reality to objective measures of behaviour (Corral-Verdugo, 1997; McGuire, 1984). According to McGuire (1984) self-report surveys assess attitudes, ideas, and beliefs about behaviour, and, as such, self-reports may be more reflective of these psychological variables than actual behavioural performance. In support of this notion Gatersleben, Steg and Vlek (2002) showed that attitudinal variables were more closely related to self-reported pro-environmental behaviour than actual household energy use.

A second reason is the ability of an individual to provide accurate data on behalf of the household. If there is low correspondence between self-reported household behaviour and objective household outcomes, a relatively straightforward reason might be that, because individuals do not necessarily have access to the behaviour of all householders, they cannot provide accurate estimates of behaviour on behalf of the household. If this were the case, then the number of people in the household should moderate the relationship between self-reported behaviour and objective household outcomes with a stronger relationship in households with fewer people than in households with more people.

On the other hand, if self-reports of behaviour more accurately reflect a 'psychological' reality that does not necessarily reflect behavioural performance, then the number of people in the household will have little impact on self-reported behaviour. Instead, it may be psychological variables that influence the relationship. In particular, the theory of planned behaviour (Ajzen, 1991) suggests that when people hold more favourable attitudes, perceive more supportive norms, and feel a greater sense of control in relation to a behaviour, this will translate into stronger intentions and subsequent behaviour. Based on this reasoning, it is possible that these three variables may moderate the relationship between self-reported behaviour and household outcomes with a stronger relationship emerging when people have more favourable attitudes, perceive more supportive norms, or have greater perceived control over the behaviour. This moderating effect may emerge because the positive psychological stance toward the behaviour may attune individual householders more to the behaviour of the household and make their judgements of the household's behaviour more accurate. Another possibility is that because householders who report positive attitudes, supportive norms, or higher control in relation to the behaviour will likely have greater commitment to the behaviour, the link between self-reported behaviour and household outcomes will be closer; this may be because either they are the driving force behind the behaviour in the household and/or because they motivate others in the household to engage in the behaviour.

1.2 The current research

In the current research we test two hypotheses based on the reasoning we advance above in the context of household recycling and water conservation behaviours.

Hypothesis 1: Household size will moderate the relationship between self-reported and objective measures of household recycling and water conservation with a stronger relationship between self-reported and objective behaviour in households with fewer rather than more people.

Hypothesis 2: Attitudes, perceived norms, and perceptions of control in relation to household recycling and household water conservation will moderate the relationship between self-reported and objective household recycling and water conservation. Specifically, the relationship will be stronger when respondents have more positive attitudes, perceive more normative support, and/or have greater perceived control.

The current research makes an important contribution to the research by moving beyond the focus on individual behaviour to examine pro-environmental behaviour within households, a significant site of environmental impacts. The meta-analysis by Kormos and Gifford (2014) included studies of both individual and household pro-environmental behaviours and explored a set of socio-demographic and methodological variables as potential moderators of the self-report – objective behaviour relationship. Our differs from that in focusing specifically on household environmental outcomes and the utility of using individual self-reports as proxies for these outcomes. Moreover, it investigates whether the number of people in the household, attitudes, norms, and control moderate the relationship between self-reported and objective household recycling and water conservation. To our knowledge, these hypotheses have not been tested previously.

2. Study 1

The focus of Study 1 is household recycling. In Australia, kerbside recycling has been in place for well over ten years and is a widely accepted practice with 98% of Australian households participating in the program (Australian Bureau of Statistics, 2006). However, there is also evidence that the amount of recyclable materials put out for collection is less than optimal (Nolan-ITU Pty Ltd, 2002). In addition to measures of attitudes, norms, and perceived behavioural control (measured through perceived ease), Study 1 also included a measure of objective recycling knowledge as we reason that this variable may also relate to actual control in that it is more difficult for people to recycle if they do not know what they can or cannot recycle. Past research has also shown that

knowledge is positively associated with greater recycling (Hornik, Cherian, Madansky, & Marauama, 1995; Schultz, Oskamp, & Mainieri, 1995).

2.1 Method

2.1.1 Participants and procedure

Participants were recruited to take part in a larger study investigating ways to improve kerbside recycling. The broader research program involved households committing to completing multiple questionnaire surveys administered over time, taking part in an intervention study, and providing permission to audit the household's bins. The current study focused specifically on responses to the initial questionnaire and the bin audits that took place concurrently. We only include data for households who completed a questionnaire and had their bins audited. The final sample for analysis was 115. The age of participants ranged from 15 – 19 to 75 and over with 48% in the 30 to 39 and 40 to 49 age groups, and 37% evenly spread across the 25 to 29, 50 to 59 and 60 to 64 age groups. Of the respondents who completed the questionnaire, 34% were males and 66% were females and two did not indicate their gender. In terms of education, the highest level of household education was relatively evenly spread across secondary school (28%), technical or trade qualifications (26%), and university (28%). The number of people in the household ranged from one to eight with a mean number of 3.00 (SD = 1.51).

Participants were residents of a regional Australian city who lived in free-standing houses. Interviewers approached every second household within the study areas, selecting the house on either side if no one was at home in the first-selected household. To obtain a valid measure of objective household recycling, residents were approached as close to bin collection days as possible (bin audits were conducted within two to three days of signing up to the study). The study was introduced to participants as research that sought to increase household recycling in the region. To be eligible to participate, residents needed to be 18 years or over and willing to take part in all aspects of the research. Interviewers

left a questionnaire with the resident to complete, and arranged to collect the questionnaire at a later time point (usually within 24 hours).

2.1.2 Measures

The term ‘kerbside recycling’ was defined for participants at the beginning of the questionnaire (i.e., waste that is recycled by putting it in a yellow-lidded wheelie bin that is put out for collection). Attitudes to kerbside recycling were measured with six semantic differential items (e.g., bad/good, inconvenient/convenient, unfavourable/favourable) drawn from previous research (e.g., Fielding et al., 2008). Participants responded on bipolar 7-point scales that ranged from -3 to +3 (e.g., -3 extremely bad, -2 quite bad, -1 slightly bad, 0 neither, +1 slightly good, +2 quite good, +3 extremely good). The mean of the six items formed a reliable scale ($\alpha = .90$) with higher values indicating more positive attitudes to household recycling. Perceived community recycling norms were assessed with three items: “Most members of my community currently recycle” (1 strongly disagree, 7 strongly agree), “Most members of my community would think that my recycling my waste is: (1 undesirable, 7 desirable)”, and “How much agreement is there amongst members of your community that recycling is a good thing? (1 very little agreement, 7 a great deal of agreement) ”. The mean of the three items formed a reliable scale ($\alpha = .70$) with higher values indicating more supportive community recycling norms. Perceived control was measured in two ways: Ease of recycling was measured by asking how easy it is for the household to separate their waste into recyclable and non-recyclable items, measured on a 7-point scale (1 = very difficult, 7 = very easy). Objective recycling knowledge was measured through presenting respondents with a list of 18 items and asking them to indicate whether they could be recycled or not (yes, no, not sure). Responses were coded 1 for a correct answer (e.g., correctly identifying that paper, newspaper and magazines can be recycled) and 0 for incorrect (e.g., incorrectly saying that

light bulbs can be recycled). Responses to each of the 18 items were summed to form an index of recycling knowledge, with higher scores representing greater knowledge.

Self-reported recycling was measured with one item: "How much of your total household waste do you think you recycle?" (1, none at all, 2 a little, 3 a medium amount, 4 quite a lot, 5 all that can be recycled). Participants also reported their gender and age category (e.g., 30 - 39) as well as the number of people in the household. The highest level of education of the respondents as well as the highest level in the household was assessed (e.g., primary school, secondary school, trade/technical qualification, university).

Objective household recycling was assessed with bin audits that were conducted by a professional waste audit company who were blind to the aims of the research. Both the recycling and ordinary waste bin for each household were audited to assess the amount (in kilograms) of materials put in the recycling bin, the amount of recyclable material put in the ordinary waste bin, and the amount of recyclable material put in plastic bags in the recycling bin (note that in the area studied, recyclables in plastic bags could not be recycled at the time). We computed a proportional measure of recycling that represents the amount of materials that were accurately recycled of all possible materials that could be recycled. We did this by dividing the amount of recyclable materials correctly put in the recycling bin by the total of recyclable materials (materials that were correctly put in the recycling bin + recyclable materials put in the normal rubbish bin + recyclable materials put in plastic bags). Thus, the measure could range from 0 indicating that none of the recyclable materials were correctly recycled to 1 indicating that all recyclable materials were correctly recycled.

2.2 Results and discussion

The means, standard deviations and correlations amongst variables are shown in Table 1. On average, respondents reported recycling between "quite a lot" and "all that can be recycled". Mean objective recycling levels were .70 indicating that households

correctly recycled 70% of all materials that could be recycled. Mean levels of recycling attitudes, norms, and ease of sorting were all relatively high. Objective recycling knowledge was relatively high with respondents on average identifying correctly whether or not 14 of the 18 materials could be recycled. The focal correlation between self-reported and objective recycling was positive and significant but weak indicating that the more householders reported that they recycled, the more the household objectively recycled. Inspection of Table 1 also shows that self-reported recycling had stronger relationships with community recycling norms and ease of sorting than objective recycling, a pattern that is consistent with the notion that self-reports reflect a psychological reality rather than 'actual' reality (Corral-Verdugo, 1997). It is also evident that objective recycling is significantly and weakly negatively related to the number of people in the house and significantly and weakly positively related to recycling knowledge.

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

Variable	M (SD)	1	2	3	4	5	6	7
1. Self-reported recycling	3.65 (.95)	-						
2. Objective recycling	.70 (.26)	.26**						
3. No in the house	3.00 (1.51)	-.13	-.21*					
4. Attitude	2.23 (.94)	.12	.06	.08				
5. Community norm	5.19 (1.05)	.38**	-.03	-.19	.21*			
6. Ease of sorting	5.93 (1.21)	.48**	.18	-.11	.25**	.26**		
7. Recycling knowledge	14.25 (2.19)	.24*	.29**	-.12	.11	.28**	.25*	-

* p<.05; **p<.01

2.2.1 Hypothesis testing

To address Hypothesis 1 and 2, we ran a series of moderated regression analyses using Hayes (2013) Process macro, testing number of people in the household, attitudes,

perceived community norms, ease, and recycling knowledge as potential moderators. Continuous predictor variables were centred prior to being included in the model. Note that the Process macro provides unstandardized regression coefficients for the main effects and interaction terms. Although two outliers were identified on the variable, the number of people in the household, excluding these cases did not influence the results, and therefore they were retained for analysis. As preliminary analyses controlling for demographic variables (age, gender, household education) did not influence the findings, these variables were not included in the focal analyses.

Hypothesis 1 predicted that there would be a stronger relationship between self-reported recycling and objective measures of household recycling in households with fewer people rather than more people. Consistent with the correlations in Table 1, Table 2 shows that there was a significant negative relationship between number of people in the house and objective recycling, and a significant positive relationship between self-reported recycling and objective household recycling outcomes. The interaction between the number of people in the household and self-reported recycling, however, was not significant and therefore Hypothesis 1 was not supported.

Table 2. Regression analysis testing moderators of the relationship between self-reported household recycling and objective household recycling

	B	se	t	p
Model 1 R=.33, R^2=.11, F(3,99) = 4.10, p=.009				
No in house	-.035	.017	-2.05	.043
Self-reported recycling	.064	.026	2.44	.017
No in house x self-reported recycling	-.019	.017	-1.10	.274
Model 2 R=.26, R^2=.07, F(3,111) = 2.68, p=.05				
Attitude	.001	.026	.367	.714
Self-reported recycling	.070	.026	2.72	.019
Attitude x self-reported recycling	.008	.030	.281	.779
Model 3 R=.35, R^2=.12, F(3,105) = 4.92, p=.003				
Community norms	-.038	.025	-1.54	.126
Self-reported recycling	.104	.028	3.69	.048
Community norms x self-reported recycling	.041	.023	1.80	.074
Model 4 R=.29, R^2=.08, F(3,110) = 3.34, p=.022				
Ease	.031	.026	1.18	.242
Self-reported recycling	.056	.030	1.91	.059
Ease x Self-reported recycling	.026	.022	1.18	.242
Model 5 R=.35, R^2=.13, F(3,102) = 4.90, p=.003				
Recycling knowledge	.032	.012	2.75	.007
Self-reported recycling	.046	.026	1.75	.084
Recycling knowledge x self-reported recycling	.012	.011	1.07	.288

Note. Degrees of freedom vary due to missing values on some variables.

To test Hypothesis 2 that attitudes, community norms, behavioural control (assessed in this study as ease and knowledge) may moderate the relationship between self-reported and objective recycling, four regression analyses were run each including one of the variables as a potential moderator. Note that inclusion of the other potential

moderators as covariates (e.g., when testing the interaction with community norms, attitudes, ease, and knowledge were included as covariates) did not change the significance of the interactions and for simplicity they are not included in the model. Table 2 shows that the interaction between perceived community recycling norms and self-reported recycling approached significance (p = .074), but none of the other interactions was significant. We followed up this marginal interaction by conducting simple slopes examining the relationship between self-reported recycling and objective recycling at higher perceived community recycling norms (i.e., one standard deviation above the mean) and at lower perceived community recycling norms (i.e., one standard deviation below the mean). The simple slopes analysis revealed that self-reported behaviour was only marginally significantly related to objective recycling when respondents perceived less support for recycling in the community (β = .22, t = 1.85, p=.068), but there was a significant and positive relationship when respondents perceived more recycling in the community (β = .523, t = 3.61, p<.001) (see Figure 1).

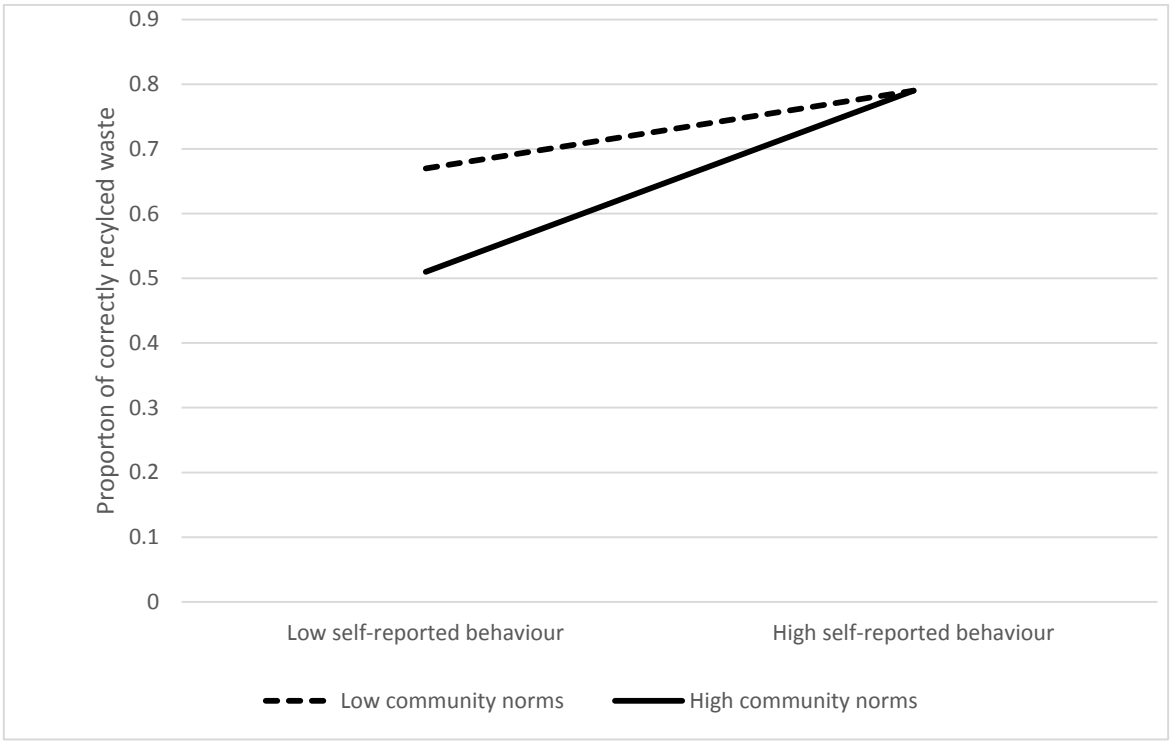

Figure 1. Perceived community norm x self-reported behaviour interaction on objective recycling (i.e., proportion of correctly recycled waste)

In summary, results of Study 1 demonstrated a significant but weak positive relationship between individual self-reports of how much waste a household recycles and objective measures of household recycling. The number of people in the house did not moderate the relationship between self-reported recycling and objective household recycling. However, there was some indication that the relationship was stronger when respondents had greater perception that others in the community are recycling. Although this finding must be treated with caution as it did not reach conventional levels of significance, it nevertheless suggests that there might be a stronger alignment between what householders say their household does and what they actually do when there are stronger perceptions that others in the community are participating in the behavior: that is, when there is greater normative support for the behaviour.

3. Study 2

In the second study we test the hypotheses in the context of household water conservation. Like recycling, household water conservation is the outcome of accumulated actions on the part of (sometimes) multiple household members. Study 2 allows a more rigorous test of the hypotheses in that we collected a larger sample and were able to access household water use for the six months preceding the survey. The second study also allowed us to test the hypotheses in a different, and potentially more complex, behavioural domain. In Study 2, norms were measured as subjective norms, that is, perceived support from important others to engage in a behaviour; perceived behavioural control was assessed through self-efficacy in relation to water conservation.

3.1 Method

3.1.1 Participants and Procedure

Participants were recruited via an online panel and through direct mail from four local government areas in the South East Queensland Region of Australia. The survey, part of a larger project focused on household water conservation, was conducted in

September 2009 and household water use was collected for the 6 months preceding the survey. The research was presented as a study about household water use in South East Queensland. Direct mail participants were sent a small incentive (tea bag and pen) with the questionnaire and online panel participants were provided a small financial incentive (AUD 10) for their participation. Because of the need to obtain objective measures of water use, participants were homeowners of a free-standing dwelling who were not intending to move residence in the next 12 months and who provided consent to access their household water use data from the appropriate water utility. Only households who completed a survey and for whom water data could be accessed were included in the analysis for this study.

In total, 1179 surveys were returned via the direct mail recruitment method (27% response rate) while 570 households completed the online survey (79% response rate). The final sample of households for whom objective water use data was available (i.e., who provided consent to access their data) was 1008: 868 households recruited via direct mail and 140 recruited via online panel. The mean age of the sample was 54.67 (SD = 14.73) with a range of 18 to 95 years. There were 43.2% males and 56.6% females, and the mean household size was 2.70 (SD = 1.31) with a range of 1 to 10. Household income was relatively evenly spread with the majority of households (61%) earning under $90,000 per annum (18% <$30,000, 21% $30,000 – 59,999, 23% $60,000 – 89,999) and 24% over $90,000; 15% did not report their income.

3.1.2 Measures

At the beginning of the questionnaire, water conservation was defined for participants as everyday actions to save water around the house and garden, and a list of these actions was provided (i.e., those behaviours that were asked about in the questionnaire). Attitudes were measured with five of the six items from Study 1 (excluding the favourable/unfavourable item). The mean of the five items formed a reliable scale with

higher values indicating more positive attitudes (α = .73). Subjective norms were measured with three items, such as, "People who are important to me want me to save water around the house and garden", and "It is expected of me that I save water around the house and garden" (1 = Strongly disagree, 7 = Strongly agree). The mean of the three items formed a reasonably reliable scale with higher values indicating more supportive subjective norms (α = .61). Self-efficacy was assessed with the item: "How confident do you feel in general about your ability to save water? (1 = not at all confident, 7 = very confident). Demographic variables included age, gender, household gross annual income, respondents' highest level of education as well as the focal variable, number of people who live in the household. Water efficient infrastructure was assessed by asking respondents to indicate whether they had installed each of ten water efficient appliances (e.g., low flow taps and/or shower heads on all fittings, water-wise plants and/or gardens, dual-flush or composting toilet, shower timer, rainwater tank plumbed into the house, water-wise washing machine, water efficient dishwasher). A water efficient appliance index was computed that reflected the number of appliances installed with values that could range from 0 to 10.

Self-reported water conservation behaviour was measured by asking householders how often in the last six months they had engaged in six water conservation actions (check and fix leaks, have shorter showers, use half flush or don't flush every time, only do full loads of washing, use minimal water in kitchen, turn off taps when brushing teeth). Responses were measured on a 5-point scale (1 = Never, 5 = Always). A self-reported behaviour index was created by adding participants' responses for each of the behaviours. The index could range from 6 to 30 with higher values representing greater reported engagement in water conservation habits. Note that we included only indoor water using behaviours in the self-report index, as outdoor behaviours did not apply to all households.

This introduces a methodological reason for lower correspondence between self-report and objective outcomes, which we return to in the discussion.

Objective household water use was assessed by accessing the average daily water use for each household for the six months preceding the survey from the appropriate water utility. Household water use was positively skewed; therefore, consistent with past research (Campbell, Johnson, & Larson, 2004), it was log transformed.

3.2 Results and discussion

3.2.1 Overview of analyses

Table 3 shows the means, standard deviations and the bivariate correlations among the focal variables. On average, respondents reported high levels of water conservation behaviours and very positive attitudes towards engaging in water conservation behaviours. Subjective norms and self-efficacy were also relatively high, and respondents had installed an average of 5 out of a possible 10 water efficient appliances in their home. The focal correlation between self-reported behaviour and objective household water use was negative and significant, albeit weak. This demonstrates that the more water conservation behaviours that respondents said their household engages in, the less water they had used. Further inspection of the correlations shows that self-reported behaviour was most strongly correlated with self-efficacy, and to a lesser degree with attitudes, subjective norms, and water efficient appliances. Not surprisingly, objective water use was positively and strongly correlated with the number of people in the household. To a lesser degree, objective water use was negatively and significantly correlated with self-efficacy, and positively and significantly correlated with water efficient appliances, although the latter correlation is weak. The correlation between efficient appliances and water use is surprising in that it suggests that the more of these that households have, the more water they use.

Table 3. Means, standard deviations, and bivariate correlations for Study focal variables

Variable	M SD	1.	2.	3.	4.	5.	6.	7.
1. Self-reported behavior	26.72 (2.84)	-						
2. Objective water use	388.50 (254.74)	- .17**						
3. No. in home	2.69 (1.30)	-.08*	.50**					
4. Efficient appliances	5.17 (2.10)	.24**	.10**	.16**				
5. Attitudes	6.28 (.63)	.29**	-.07*	.04	.14**			
6. Subjective norms	5.75 (.85)	.27**	.01	-.01	.09**	.31**		
7. Self-efficacy	5.78 (1.08)	.43**	-.16**	-.02	.22**	.35**	.24**	-

Note. *p<.05; **p<.01; water use is in litres per household per day; self-reported behaviour could range from 6 – 30; efficient appliances could range from 0 – 10; attitudes, subjective norms, and self-efficacy were all measured on 7-point scales

3.2.2 Hypothesis testing

The same analytic approach was taken in Study 2 as in Study 1 except that in Study 2, the water efficient appliance index was included as a control variable. As in Study 1, all continuous predictor variables were centred prior to analysis.

The first model tested Hypothesis 1 that the relationship between self-reported water conservation and objective water use would be moderated by the number of people in the house. Consistent with the correlations shown in Table 3, the number of people in the house emerged as a significant positive predictor of household water use, and self-reported water conservation behaviour emerged as a significant negative predictor. The interaction term, however, was not significant indicating that the relationship between self-reported behaviour and objective behaviour was not moderated by the number of

people in the household. This finding is consistent with the results of Study 1 that also found no moderating effect of the number of people in the household.

Models 2 to 4 tested the hypothesis that attitudes, subjective norms, and self-efficacy would moderate the relationship between self-reported behaviour and objective household outcomes. Note that preliminary analyses controlling for the other potential moderators in each analysis (e.g., when testing the interaction with attitudes we controlled for subjective norms and self-efficacy) showed that inclusion of these covariates did not change the significance of the interactions. For simplicity we therefore only include the focal moderator in each model. As Table 4 shows, there was a significant interaction between attitudes and self-reported water conservation behaviour, subjective norms and self-reported behaviour, and self-efficacy and self-reported behaviour. We conducted simple slopes to follow up these interactions. As Figure 2 shows, the relationship between self-reported water conservation behaviour and objective household water use was stronger when respondents reported more favourable attitudes (β = -.31, t = -6.34, p<.001) than when they reported less favourable attitudes to water conservation (β = -.13, t = -3.18, p=.002). The pattern was the same for the other two interactions: the relationship between self-reported water conservation and objective household water use was stronger when respondents reported more supportive subjective norms (β = -.32, t= -6.57, p<.001) than when they reported less supportive subjective norms (β = -.17, t= -4.23, p<.001) and there was a stronger relationship between self-reported behaviour and objective water use when self-efficacy was higher (β = -.29, t= -5.77, p<.001) than lower (β = -.09, t= -2.40, p=.017).

433 Table 4. Regression analysis testing moderators of the relationship between self-reported

434 water conservation and objective household water use

	b	se	t	p
Model 1 R=.52, R^2=.27, F(4,890) = 83.16, p<.001				
No in house	.097	.006	16.58	.000
Self-reported water conservation	-.014	.003	-4.98	.000
No in house x self-reported water conservation	.001	.002	.540	.589
Water efficient appliances	.006	.004	1.57	.116
Model 2 R=.24, R^2=.06, F(4, 894) = 14.04, p<.001				
Attitude	-.017	.015	-1.18	.240
Self-reported recycling	-.021	.015	-6.31	.000
Attitude x self-reported recycling	-.014	.004	-3.21	.001
Water efficient appliances	.017	.004	4.03	.000
Model 3 R=.24, R^2=.06, F(4, 892) = 13.80, p<.001				
Subjective norms	.011	.011	1.01	.313
Self-reported recycling	-.023	.004	-6.80	.000
Subjective norms x self-reported recycling	-.008	.003	-2.91	.003
Water efficient appliances	.017	.004	4.17	.000
Model 4 R=.28, R^2=.08, F(4,894) = 19.46, p<.001				
Self-efficacy	-.042	.009	-4.69	.000
Self-reported recycling	-.018	.004	-5.07	.000
Self-efficacy x Self-reported recycling	-.009	.002	-4.19	.000
Water efficient appliances	.018	.004	4.44	.000

435 Note. Degrees of freedom vary due to missing values on some variables.

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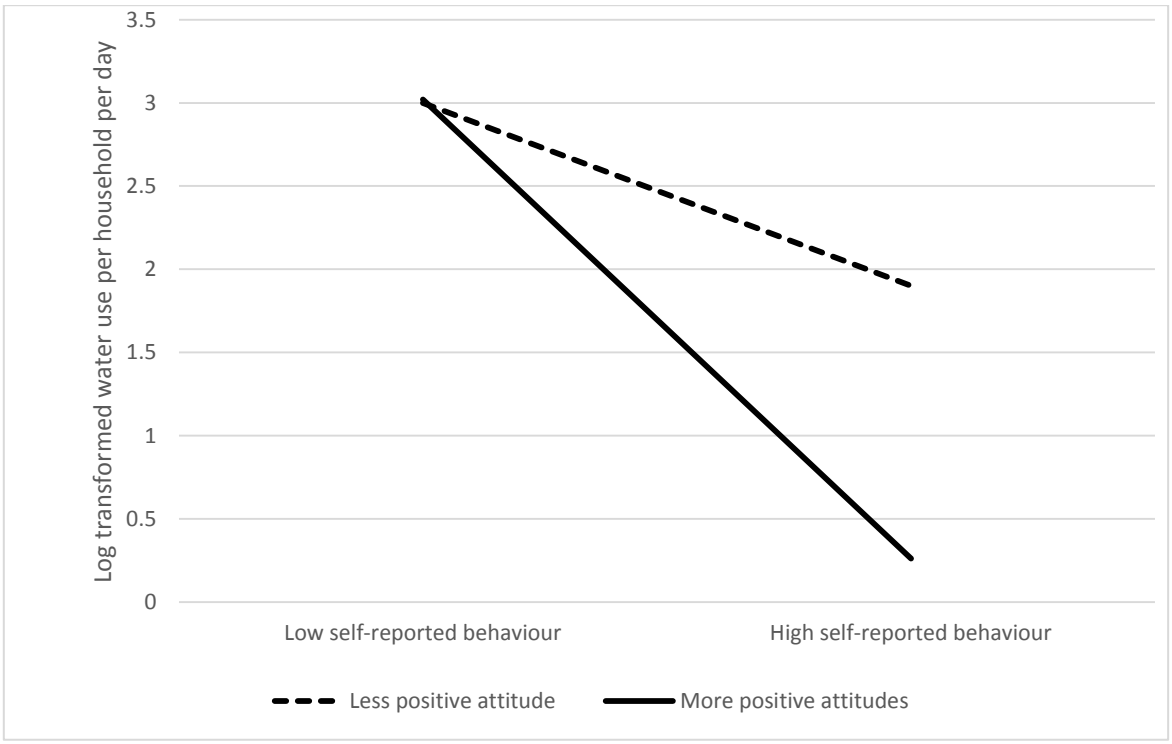

Figure 2. Attitude x self-reported behaviour interaction on objective household water use

In summary, Study 2 shows a significant, albeit weak negative relationship between self-reported household conservation behaviour and objective household water use: respondents who reported more household water conservation had lower household water use. There is no evidence that reporting on the behaviour of more people in the household undermines the correspondence between self-reported water conservation behaviour and objective household water use. Instead, the current findings suggest that it is the extent to which people feel more positive toward water conservation, perceive that important others support water conservation, and feel greater self-efficacy in relation to water conservation that guides the extent to which self-reported behaviour and objective outcomes are in alignment. Hence, the correspondence is lower when attitudes, subjective norms, or perceived control are more negative, and stronger when these variables are more pro-conservation.

4. General discussion

The focus of the current research was to investigate how well individual self-reports of household recycling and water conservation map on to actual household environmental outcomes and also to explore whether there are moderators of this relationship. The results were consistent across the two studies: in both studies there was a significant but weak relationship between self-reported behaviour and objective measures of behaviour, that is, proportion of materials correctly recycled in Study 1 and amount of water used in Study 2. Past studies have shown stronger correlations between self-reported and observed behavior (Corral-Verdugo, 1997; Corral-Verdugo & Figueredo, 1999; Kormos & Gifford, 2014). Recycling and water conservation are environmental domains that rely on a range of behaviours, and this complexity may make it more likely for self-reports to be influenced by self-perceptual biases.

Our findings both support and qualify the use of self-reported household behaviour by individuals as a proxy for objective household behaviour. We demonstrate a consistent and significant relationship between the measures across the two studies, but the low correlations also confirm the importance of trying to find ways to increase this correspondence. The health literature has focused on the validity and accuracy of self-reported behaviour and suggests that strategies that could improve self-report accuracy include ensuring that respondents understand the questions, wording questions in ways that reduce social desirability bias, ensuring response options are clear, exhaustive, and mutually exclusive, and using a "bogus pipeline" approach whereby respondents believe that their self-reports can be objectively verified (Newell, Girgis, Sanson-Fisher, & Savolainen, 1999). In relation to self-reported pro-environmental behaviour, Kormos and Gifford (2014) highlight the need for more precise and less vague response options (e.g., 'sometimes', 'often').

We reasoned that one barrier to greater correspondence between self-reported and objective household behaviour might be that it is difficult for individuals to have access to

the behaviour of all householders. Therefore they might be more accurate in their reports (and therefore there will be greater correspondence between measures) when they are reporting only on their own behaviour or that of a small number of individuals rather than a larger number of householders (Hypothesis 1). Across the two studies we did not find any evidence for this hypothesis in that the number of people in the household did not moderate the relationship between self-reported and objective behaviour. Instead, in support of Hypothesis 2, the results of the two studies suggest that it is the extent to which people have more positive attitudes to water conservation (Study 2) and perceive more supportive norms (Study 1 & 2) or feel greater self-efficacy (Study 2) that influences the correspondence between self-reports and objective behaviour.

These findings make sense from the perspective of the theory of planned behaviour (Ajzen, 1991). According to this model, when people have more positive attitudes, perceive more supportive norms, and have a sense that they can easily undertake the behaviour, they have stronger intentions, which is considered a measure of their motivation toward the behaviour. What our findings suggest is that holding more positive attitudes, perceiving more normative support and having greater self-efficacy made it more likely for respondents to give a more accurate account of household behaviour, one where there was closer alignment between what respondents said the household does and what they actually do. One way to think about this finding is that these psychological variables attune people more to the reality of the household's behaviour. For example, if you think recycling is important and a beneficial thing to do and/or if you think it is something that others approve of and are engaging in, you may be more likely to notice how well your household is performing on this dimension, and more accurate in your reporting. Of course, whether this pattern extends beyond the household environmental domains of recycling and water conservation remains a question for future research.

5 Limitations and conclusions

5.1 Limitations

In the current research we used environmental outcomes as the measure of objective behaviour. Although this is relatively straightforward for recycling—the proportion of recycling is made up of the individual recycling actions of household members—water conservation is a more complex environmental domain. The amount of water that is saved not only depends on the actions of household members but also the number of water using appliances in the household and the water efficiency of those appliances. For this reason we would expect to see lower correspondence between self-reports of water conservation and objective water conservation than for some other environmental domains because other factors influence overall household water use. As noted earlier, we measured self-reported behaviour in relation to indoor water use whereas objective water use reflects both indoor and outdoor uses. The relationship between self-reported and objective water conservation behaviour could be diminished because of this. It is important to note, though, that water end-use research conducted with a sample of households from this study showed that less than 5% of household water use at the time of the research was attributable to outdoor water use (Beal, Stewart & Fielding, 2011). Thus, external water use alone cannot explain the magnitude of the discrepancies. Future research might explore ways of attuning people to their water usage more closely, for example by making usage more immediately visible to householders.

5.2 Conclusion

In conclusion, the current research goes beyond past studies that have examined the correspondence between self-reported and objective measures of environmental behaviour by examining this question in the context of complex household behaviours. We show significant relationships between individuals' self-reports of household behaviour and objective household outcomes, although the correspondence is relatively weak. We also show that correspondence is greater when individual respondents report

more positive attitudes, perceive greater normative support, and feel more self-efficacy in relation to the behaviour, suggesting that psychological variables influence the accuracy of their reports. Not only are respondents who are less pro-environment in their attitudes, norms, and control perceptions less likely to engage in pro-environmental behaviours, their reports of environmental behaviour may also be less accurate than are more pro-environment respondents' self-reports. These findings highlight the importance of multiple modes of data collection and the importance of considering the collective nature of environmental behaviour in future research. In light of the practical and financial barriers to surveying multiple householders, they also highlight the need for future research to find ways to improve the accuracy of individuals' responses.

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