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Informing public attitudes to non-potable water reuse – The impact of message framing

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ABSTRACT

Water reuse is of increasing relevance for water-stressed regions but is often considered a contentious option. Research has shown that providing the public with information about reuse options can impact positively on its acceptability, although such impacts can be confined to specific groups. In this context, there is growing interest in understanding the impact of different forms and mechanisms of communication with the public around reuse. This contribution has investigated the use of video animations to communicate the safety of non-potable recycled water schemes. The aim of this study was to evaluate how different ways of framing messages about the safety of recycled water might impact on public attitudes. Participants were recruited in London ($n = 689$), UK, and randomly allocated to test and control groups, with the former being exposed to one of four video animations that used different frames to convey messages about recycled water safety. Surveys collected pre- and post-video message responses for dependent variables including the general acceptance of diverse non-potable recycled water uses, risk perceptions and trust. The findings complement existing knowledge on the impacts of different types of messaging on public attitudes to reuse schemes with important evidence for the positive impact of water safety communications framed in terms of compliance with water quality requirements. Contrarily, a positive attitudinal impact was not evident for safety message framed in terms of the selection of water treatment technology to remove contaminants nor in terms of non-potable water risks relative to other every-day risks. The results are of value to water resource planners looking to develop communication resources, as part of more comprehensive public engagement strategies, for improving perceptions of water reuse. Importantly, the findings help isolate the effects of specific message frames, and inform the debate on whether an increased understanding of risk positively or negatively influences willingness to support water reuse schemes.

1. Introduction

The perceived benefits of early public engagement in the planning and design of water reuse schemes (Frijns et al., 2016; Hurlimann and Dolnicar, 2016; Lee and Tan, 2016) are clearly supported by water reuse regulations and guidelines (European Commission, 2016; NRMMC EPHC & AHMC, 2006; USEPA, 2012). This aspiration for timely public engagement has also been informed by the experiences of both successful (Harris-Lovett et al., 2015) and unsuccessful (Hurlimann and Dolnicar, 2010) reuse schemes involving both potable and non-potable recycled water uses. The evidence has consistently linked inadequate public engagement with low public support for, or increased levels of resistance to, reuse projects (Russell et al., 2008). More inclusive dialogue about risks and benefits is often recommended to help understand public attitudes and to build public trust (Khan and Gerrard, 2006).

The repurposing of wastewater for non-potable uses is consistently evaluated by the public to be less contentious than its reuse for drinking water (Hurlimann and Dolnicar, 2016). However, there are well-recognised nuances within this general principle that relate acceptability to the degree of contact with, or exposure to, the water (Bruvold, 1988; Friedler et al., 2006; Hurlimann et al., 2009). For example, use of the water for higher exposure uses, such as in swimming pools, is likely to be less acceptable than for flushing toilets (Dolnicar and Schäfer, 2009). Explanations for these

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differences draw from the psychology of contamination and disgust (Rozin et al., 2015; Wester et al., 2016), and from cultural risk evaluations, suggesting preferences for more 'pure' uses (Marks et al., 2008). These differences are well documented but can also vary depending on context. As examples, there are cases of 'overwhelming' public acceptance for schemes involving potable reuse (e.g. NeWater, Singapore - Mainali et al., 2011) and underwhelming acceptance for uses such as toilet flushing (Buyukkamaci and Alkan, 2013). Health risk fears can lie behind public concerns, with specific evidence emerging from cases involving irrigated crops (Wu et al., 2015) and cross-contamination in household drinking water supplies (Hambly et al., 2012). There is now a sizeable legacy of research that has engaged with the challenge of understanding the factors underpinning public acceptance (Bruvold, 1988; Dolnicar et al., 2011; Nancarrow et al., 2008; Ross et al., 2014). However, contemporary developments have seen increasing interest in understanding how and why public attitudes evolve (Fielding et al., 2018; Smith et al., 2018).

Initial negative reactions towards water reuse can be moderated through effective communication (Leong, 2016, 2010; Russell and Lux, 2009) and individuals can re-evaluate their attitudes when provided with information (Dolnicar et al., 2010; Russell et al., 2008; Wester et al., 2016) – although there can also be challenges to gauging, and interpreting, the impact (Fielding et al., 2018). How people react to information about water reuse is thought to depend to a greater extent on the information processing experience (Dolnicar et al., 2010; Russell et al., 2008). As such, there is keen interest in understanding communicative processes – in particular, how framing (e.g. the careful selection or emphasis of certain pieces of information) might influence how people make sense of water management communications (Dewulf et al., 2009, 2005; Mankad, 2012). For water reuse, studies have shown positive impacts from providing information that adopts particular terminology (Menegaki et al., 2009; Simpson and Stratton, 2011), includes descriptions of water treatment processes (Dolnicar et al., 2010), or identifies risks and benefits of recycled water (Price et al., 2015). Contrastingly, research has shown no impact from providing additional information on pollutant levels (Fielding and Roiko, 2014). Presently, there remain limitations to knowledge of how specific communities might respond to different message framing and which modes of communication are more effective (Fielding and Roiko, 2014; Rozin et al., 2015; Russell et al., 2008).

Recent years have seen an increase in the deployment of graphical materials (Dolnicar et al., 2010), and animations and videos in particular (Russell et al., 2008), to present information about water reuse. The associated benefits of using such media include improvements in accessibility and understanding (Ishii and Boyer, 2016; Islam et al., 2015; Tang et al., 2015). Videos can help viewers grasp more complex resource management concepts (Krantz and Monroe, 2016), and the selection of certain images may help develop positive responses towards water augmentation projects (Dolnicar et al., 2014). Videos are an increasingly familiar information source, and can enhance levels of interest and motivation (Arvai and Louie, 2014). Such demonstrated benefits have led to the development of video animation resources discussing water management (e.g. Sydney Water's 'tap™' video - Motion and Kearnes, 2014) and, specifically for water reuse, videos describing *de facto* indirect potable reuse ('Downstream' - Harris-Lovett et al., 2015), direct potable reuse ('The Ways of Water' - WateReuse, 2014) and sewer mining (DESSIN, 2017). Despite the growing use of video messaging, scientific evaluations of video interventions are sparse (Arvai and Louie, 2014).

This paper aims to examine the impact of message framing on public attitudes towards non-potable water reuse through the use of video messages that selectively communicate information regarding the risk management of non-potable recycled water use in London. Following the principles of framing (to select some aspects of a perceived reality and make them more salient to promote a particular idea or problem - Entman, 1993), the content of the different video messages used in this study included different focal characteristics, depending on the frame being employed (Hallahan, 1999; Levin et al., 1998). This paper therefore addresses the following questions: (1) To what extent might the initial attitudes of the participants towards non-potable recycled water be influenced by messages conveyed through video animations? (2) To what extent might message framing (variation in the focal characteristics of a message according to the frame being employed) influence attitudinal change? (3) To what extent might the impact of message framing be associated with initial levels of support for more contentious non-potable water uses or demographic variables? (4) How might messages about recycled water be improved to help meet the public's expectations (with respect to the study location of London, UK), and how might video animations be used more effectively for engaging the public when developing recycled water schemes?

2. Methodology

2.1. Participant recruitment

Participants were recruited for pre and post video message surveys from a database of over forty thousand London residents (over 18 years of age). The survey panel (Qualtrics) worked with databases of participants (including harder to reach demographic categories) to select participants to take part. Based on similar studies using online panel-based recruitment (e.g. Dolnicar et al., 2014), the response rate was expected to be in the order of 15–20%, however this was not specifically documented. Participants received a compensation payment at standard rates used by the survey company. For the initial survey at Time 1 (T_1), 783 surveys were started and 753 completed. Using a minimum time completion filter to improve data quality (set at the 10th percentile completion time), 689 valid responses were received. For the follow-up survey (T_2), 565 responses were started and 6% not completed. Using the minimum time filter, 479 valid responses were received. After matching valid responses from T_1 and T_2, the final sample of matched pairs was $N = 441$.

Demographic data was collected for gender, age, ethnicity, highest level of education and annual household income. Demographic characteristics of the valid T_1 responses included a mean age of 42.42 ($SD = 16.31$, range 18–90), with 354 females (51.4%) and 335 males (48.6%). For ethnicity, 73.1% identified as White (British, Irish or Other), 9.6% as Black or Black British, 8.1% as Asian or British Asian, 4.6% as mixed ethic background and 4.5% as any other background. These demographic proportions accorded well with the general London population over 18 years of age for age (mean = 43.39) and gender (48.8% male, 51.2% female). The sample was over representative for those identifying as white ethnicities (60% in London) and those with university degrees (38% in London compared with 51% in the sample). Characteristics of the sample validly completing both stages included a mean age of 47.40 years ($SD = 15.65$, range = 18–90), with 247 females (56%) and 194 males (44%). Attrition rates varied for different sub-groups and, for example, were higher for males, those under 35 and those from mixed and Asian or British Asian ethnic backgrounds. Using cross-tabulation (Pearson Chi-Square), the proportions for gender ($\chi^2 = 2.816$, $df = 1$, $p = 0.093$), ethnicity ($\chi^2 = 3.973$, $df = 5$, $p = 0.553$), annual income ($\chi^2 = 0.506$, $df = 5$, $p = 0.992$) and level of education ($\chi^2 = 6.446$, $df = 10$, $p = 0.776$) were not significantly different between the two sample points. However, the change in the distribution of participants between the age categories was statistically significantly ($\chi^2 = 31.041$, $df = 5$, $p = 0.001$) and the implications of this were explored in the analysis.

The final sample drawn from a database of London residents was of sufficient size to consider the possible representativeness with respect to the general London population aged over 18 of 6.4 million (GLAIntelligence, 2016) (for claims made about proportions the confidence level was 95% ±5% error). However, given the known challenges associated with sampling biases in internet surveys and panel based recruitment (Van Selm and Jankowski, 2006), potential methodological biases (e.g. acquiescence and social desirability bias) along with the biases identified in the demographic proportions of the data, any such generalisation were drawn with caveats.

2.2. Materials - survey and video design

The independent variables were message frames, which determined the selection of information for four different video messages. The video messages were created using animation software and embedded in a Qualtrics online survey instrument. The videos were designed using Sparkol's VideoScribe software. The survey instrument and videos were piloted to address design problems and to check interpretations of words and phrases (de Vaus, 2002). The survey questions and video materials were also pre-tested through consultation with a small number of water resource specialists and academics. The survey and videos were updated based on these consultations and then piloted with a small sample of the public (T_1, N = 56; T_2, N = 33). Following this, refinements were made to the question items and their wording based on Cronbach's alpha scores, qualitative feedback and comprehension check question results. As an example, a question about risk-benefit trade-offs was excluded following the review of Cronbach alpha. Other changes included simplifying the wording of questions and modifying the survey flow and the sequence and timing of the animations in the videos. These responses from the piloting were not included in the final analysis.

2.2.1. Experimental video messages

The development and the selection of the frames used in the videos drew from the broader framing literature, spanning psychology (Levin et al., 1998) and sociology (Nisbet, 2009). The message framing literature around water management and water reuse (Goodwin et al., 2017; Mankad, 2012; Menegaki et al., 2009; Rozin et al., 2015; Wester et al., 2016) was then used to develop a conceptual message framing typology (Table 1) that linked contextual, attribute and valance frames with a multi-level framing of water resource management, water reuse (as a management intervention) and water safety. This typology provided an overarching framework for constructing the messages used in this study.

A general context framing message was developed which emphasises the water supply challenge for London and the potential role of non-potable water reuse as a solution (Fig. 1). The context frames used were informed by literature related to the role of water reuse in London's water supply (e.g. Aitken et al., 2014; Bell and Aitken, 2008; Hills et al., 2001; Jeffrey and Jefferson, 2003; Smith et al., 2014) and the terminology used was informed by the water reuse communication literature (specifically Macpherson, 2014, 2011; Menegaki et al., 2009; Motion and Kearnes, 2014; Po et al., 2005; Simpson and Stratton, 2011; WRRF, 2010). This general context message video (duration of 1min 13s) employed all three levels of context framing (Table 1); it described the context for water resource management including the existing water supply regime, the influence of climate change and population growth, and the potential for a future water supply deficit (Level 1 context framing); it described the context of water reuse as a management intervention, including potential benefits (Level 2 context framing); and it described the context of water reuse safety through acknowledging potential risks from contaminants (Level 3 context framing).

In addition, three alternative water safety attribute frames (Level 3 attribute framing) were developed which added different focal characteristics to the general message: (1) 'water quality compliance' – wherein the message emphasised that management practices ensure compliance with standards (through monitoring, sampling, testing and reporting) to protect human and environmental health from contaminants (video duration 1min 37s); (2) 'relative risk' – wherein the message emphasised that contaminants may be detected in recycled water but that exposure is relative to other every-day exposures to similar contaminants, such as those in personal care products (video duration 1min 33s); and (3) 'technology selection' – wherein the message emphasised that the selection of water treatment technology (including biological treatment, carbon filtration, membrane filtration, chemical oxidation and disinfection) targets the removal of specific contaminants to protect human and environmental health (video duration 1min 30s). These three alternative attribute frames were developed by thematically reviewing water recycling studies focusing on public communications (e.g. Fielding and Roiko, 2014; Goodwin et al., 2017; Harris-Lovett et al., 2015; Price et al., 2015; Roseth, 2008; Ross et al., 2014; Rozin et al., 2015; Wester et al., 2016).

2.2.2. Dependent variables

The surveys used Likert-type questions to quantify five dependent variables. These variables were labelled: (1) general acceptance; (2) support; (3) behavioural intentions (e.g. willingness to use the water); (4) risk perceptions; and (5) trust (see Table 2). The question items used to measure each dependent variable were built on elicitation methods shown to be consistent and reliable measures (Aitken et al., 2014; Fielding and Roiko, 2014; Nancarrow et al., 2009; Po et al., 2005; Price et al., 2015; Ross et al., 2014), taking into account contextual specificities and issues identified during piloting. A range of non-potable water uses were included to span potential levels of exposure to recycled water, using general classification methods (e.g. 'low', 'medium', 'high' - Bruvold, 1988; Friedler et al., 2006; Matos et al., 2014). However, through the aggregation of question items (described below), the dependent variables sought to summarise the participants' general attitudes to non-potable recycled water rather than towards specific uses for the water.

Responses to individual question items were recorded using a 6 point scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree and 6 = don't know). A low proportion of respondents selected 'don't know' (<3%) and were re-coded as neutral/ambivalent (3) along with 'neither agree nor disagree' for analysis. To improve response validity, some questions used reverse wording (which were re-coded for analysis). For each respondent, under each dependent variable, the numerical scores for individual question items were added together (Norman, 2010). Using these aggregate values, mean values and standard deviations were calculated for each message group, for each dependent variable, at each time stage – so for the Acceptance variable, in the No-Message group, at Time 1, the mean was calculated through summing scores for all the participants in that group and dividing by the number of participants. The internal consistency for all of the variables was evaluated with Cronbach alpha to be satisfactory (Table 2). Cronbach's alpha test is commonly referred to in water management (e.g. Ishii and Boyer,

Table 1
Conceptual message framing typology for communication around water reuse, with nested levels and examples of relevant mesages.

	Overview	Level 1. Water resource management	Level 2. Water reuseas a management intervention	Level 3. Water safety
Context frames	Context to frame situations and objects (Hallahan, 1999; Pan and Kosicki, 1993). Framing for bridging cognition and culture within social contexts (Van Gorp, 2007).	The water resource context might include details of the temporal and spatial scales (Tang et al., 2015), geography, causes (e.g. climate change, population growth), consequences, people affected and alternative management options (Lyytimaki and Assmuth, 2014)	Context of the recycled water's history (Rozin et al., 2015) or contrasting international reuse examples (Price et al., 2015).	Context could include descriptions of the health risk relative to other public health issues like food safety (Price et al., 2015)
Attribute frames	Focal attributes, characteristics of objects and situations specific to a context (Hallahan, 1999; Levin et al., 1998; Mankad, 2012).	Focal attributes could be: investment (e.g. in flood defences), risk-based management approaches (Escobar and Demeritt, 2014) or the chemical quality of raw water (Lyytimaki and Assmuth, 2014).	Specific uses for the water (e.g. drinking, toilet flushing - Dolnicar et al., 2010) or specific details like energy used to process recycled water (Price et al., 2015).	Attribute frames could include details of the water treatment processes (Dolnicar et al., 2010) or levels of specific pollutants (Fielding and Roiko, 2014).
Valence frames	Positive or negative aspects of attributes: e.g. losses and gains, risky choice (probability of winning or losing something) (Levin et al., 1998; Mankad, 2012).	Potential losses such as water shortages or gains from economic opportunities (Lyytimaki and Assmuth, 2014).	Reuse as a secure water supply or negative health risks (Price et al., 2015).	Valence frames could include the use of cognitive or affective images (Wester et al., 2016)

Fig. 1. The general (contextual) video message (thumbnail shows the opening animation slide).

2016; Ross et al., 2014) and risk research (e.g. Poortinga and Pidgeon, 2003) to measure the inter-correlation of question items as an indicator of internal consistency. Debates on the usefulness and the interpretation of the alpha statistic permeate through the socio-psychological literature (Cortina, 1993), however, for this study the statistic was considered suitable for the context.

2.3. Study procedure

Following consent to participate, all participants completed the introductory survey stage with basic demographic questions and initial dependent variable measurements (Fig. 2). Participants were then randomly assigned to one of five message groups (using inbuilt survey tool functionality) to either watch a video animation or not (control group with no message). Immediately following the videos, a number of statements were used to gauge: (1) how easy the video messages were to understand (using the six point Likert scale), and (2) whether participants recognised the focal characteristics of the message to which they'd been assigned (the inclusion of comprehension checks followed Islam et al., 2015). For the latter, participants were asks whether the video helped them understand about (by selecting all that apply): (1) water resource planning, (2) water recycling, (3) water quality compliance, (4) comparing every-day risks, (5) water treatment technology, or (6) anything else (allowing for text entry). These categorical data were used to help interpret the participants' ability to recall and comprehend specificities of the messages by comparing the four message groups using Pearson's Chi-squared test.

Repeat measures were taken at two weeks with this interval selected with reference to related studies (Dolnicar et al., 2010; Price et al., 2015) and following a similar methodology to Roseth (2008). Drawing from attitude change theory, the approach assumed that: (1) attitudes should remain stable in the absence of ‘shock’ events (Krosnick and Petty, 1995) and (2) messages can initiate longer-term attitude change if participants are motivated and able to process them (Dainton, 2004). The study procedure acknowledged that attitudes could be affected by other issues coming into public attention after viewing the messages (Russell et al., 2008), but a review of local weather and news media showed that water issues were not salient and were therefore unlikely to influence participants' attitudes during the study period. Attitudes could have been influenced through reflecting on the topic after completing the initial survey (Roseth, 2008) and the no message (control) group was used to help monitor for such effects.

2.4. Analysis

All data were analysed using IBM SPSS Statistics version 22.0. Following the methodology of Fielding and Roiko (2014), outliers (scores greater than 3 standard deviations above or below the mean) were identified on the dependent variables and excluded. Following this, the data for the five dependent variables were approximately normally distributed (*skewness and kurtosis between* ± 2 for all variables). Moreover, Levene's test showed homogeneity of variance (of the five variables the risk variable has the lower test statistic of $p = 0.556$). Therefore, parametric statistics were considered appropriate for the analysis, given the robustness of ANOVA (Norman, 2010).

One-way ANOVA on the gain scores (changes over time) were used to explore whether there were differences between the five groups. The hypothesis was that: (H1) after watching the videos, there would be differences in attitudinal changes between each of the four video message groups when compared with the control group. Paired t-tests were used for the matched samples to explore whether the dependent variables changed significantly over time within each of the message groups. To explore any framing effect

Table 2
Question items used for measuring dependent variables.

Dependent variable	Question Items	Reliability[a] (α)
General acceptance (9 items)	General acceptance combines all Support & Willingness questions (see below)	0.872
Support (5 items)	1. I support using recycled water for watering gardens and flushing toilets	0.767
	2. I support using recycled water for industrial processes (e.g. electricity generation)	
	3. I support using recycled water for recreational swimming (e.g. in swimming pools)	
	4. I support using recycled water to irrigate edible food crops	
	5. I support using recycled water for washing clothes	
Willingness (behavioural intentions) (4 items)	6. I would be willing to use recycled water for watering gardens and flushing toilets	0.742
	7. I would be willing to buy a home that uses recycled water for watering gardens and flushing toilets	
	8. I would be willing to consume food irrigated with recycled water	
	9. I would be willing to swim in water containing some recycled water	
Risk perceptions (6 items)	10. Using recycled water for watering gardens or flushing toilets would cause a public health risk (reversed)	0.729
	11. The risks from using recycled water for watering gardens or flushing toilets are small compared to other everyday risks	
	12. Water treatment technology can control the risks to public health	
	13. I would accept lower quality recycled water for watering gardens or for flushing toilets if this meant avoiding a hosepipe ban	
	14. Compliance with water quality standards can control the risks to public health	
	15. Consuming food irrigated with recycled water would NOT cause a public health risk	
Trust (7 items)	16. I think that the water company has good intentions in managing London's water supply	0.868
	17. I can trust the water company to provide a good quality supply for watering gardens or flushing toilets	
	18. I trust regulators (e.g. Drinking Water Inspectorate and the Environment Agency) to set safe water quality standards	
	19. I trust regulators (e.g. Drinking Water Inspectorate, the Environment Agency) to check recycled water complies with quality standards set down in law	
	20. I do NOT trust the technology involved in water reuse (reversed)	
	21. I do NOT trust science and technology to produce safe recycled water (reversed)	
	22. I trust the government to manage the balance of a range of public health concerns in our society	

[a] Number of valid responses at $T_1 = 689$.

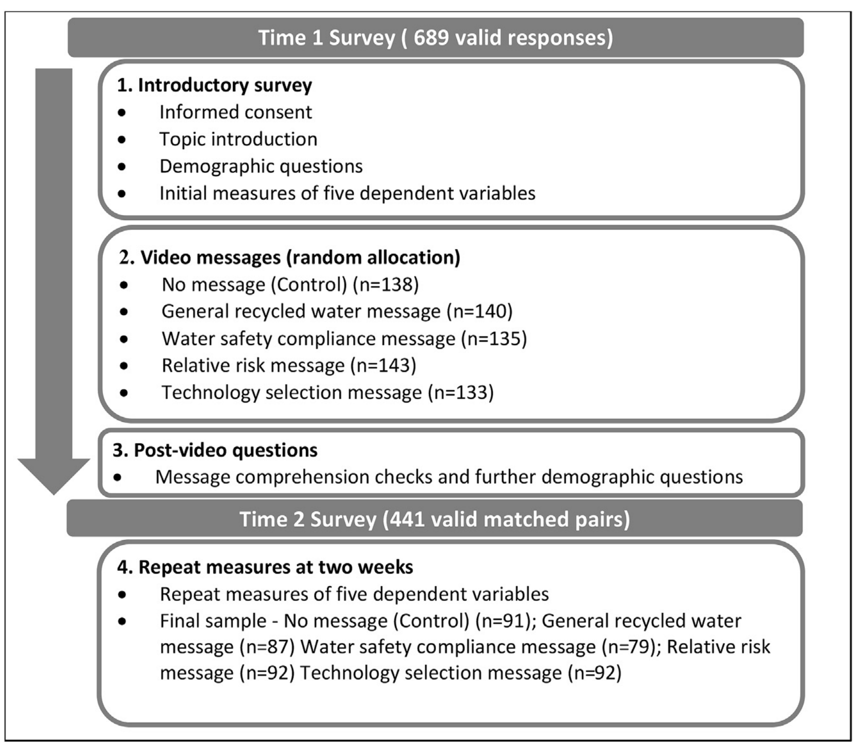

Fig. 2. Two-stage pre and post video message study procedure.

from varying the message content, again, one-way ANOVA was used but to compare only the four video message groups. The hypothesis was that (H2) there would be a difference between the four message groups ($n = 350$) and, more specifically, between each of the three messages containing specific focal characteristics when compared with the general video message group.

Finally, following the methodology of Price et al. (2015), the initial support for using recycled water in swimming areas was divided to form three groups: initially supportive (168), neutral/indifferent (85) and initially not supportive (113). The premise of this analysis was to consider whether the message framing might be influential on those initially neutral or not supportive. Support for use in swimming areas was selected for this analysis on the basis that this was the most contentious use with the highest degree of exposure to recycled water. As initial support for uses such as toilet flushing was initially high, there was limited scope to consider the change in views of those initially not supportive. The hypothesis was that (H3) initial levels of support would interact with the video message groups and the impact of the message frames. Using a univariate General Linear Model (GLM), two-way ANOVA was used to evaluate the interaction between the initial support and the four video message groups for the five dependent variables.

2.4.1. Demographic weights and variables

As attrition in younger age groups was found to be statistically significant between the surveys, the influence of age (in years) was explored as a covariate when comparing the groups (using ANCOVA through a univariate GLM). Moreover, the possible influence of differences in the demographic composition of the sample was examined through weighting, particularly with reference to the Londoner population to consider the generalisability of findings. Weighting was achieved using SPSS *weight cases* function to adjust the composition of the sample based on the frequency of demographic data for age, gender and ethnicity to be reflective of the proportions in the London population.

Age and gender were explored as independent demographic variables, as variations in both have been shown to be associated with differences in attitudes to science (Castell et al., 2014) and differences in responses to message framing (Levin et al., 1998). For example, attitudes have been shown to be more impressionable at younger ages (typically up to 25 years old - Krosnick et al., 1989), although, susceptibility to attitude change may increase again in late adulthood (Ajzen, 2001). The age group categories used for analysis were: 18–34, 35–44, 45–54, 55–64 and over 65. Two-way ANOVAs were conducted using univariate GLM to explore interactions between the demographic categories and the message groups. No firm hypotheses were made as to the expected nature of the interactions.

3. Results

3.1. Initial general acceptance of non-potable water reuse

ANOVA showed there was no significant differences in the initial attitudinal responses to the five dependent variables for the participants' who went on to be randomly assigned to the five message groups. This indicated that at T_1 no group displayed any initial attitudinal differences compared with other groups before viewing a video message. The dependent variable with the most variance at T_1 was support ($F\,(1, 440) = 1.272, p = 0.280, \eta^2 = 0.012$), whilst the least variance was for general acceptance ($F\,(1, 440) = 0.679, p = 0.607, \eta^2 = 0.006$). The results for initial support and behavioural intentions (T_1) are summarised in Fig. 3 to help contextualise the participants' responses with respect to the general patterns of agreement with respect to recycled water uses with different degrees of exposure. The highest support was for the lowest exposure uses – industrial uses (96% agreed) and toilet flushing and garden watering (92% agreed). The lowest initial support was for the highest exposure use – use in recreation swimming areas (46% agreed). The results for behavioural intentions followed a similar pattern with higher intentions to use the water for watering gardens and flushing toilets (91% agreed) and lower intentions to swim in recycled water (41% agreed). In this regard, the results were broadly representative of previous research into public attitudes to non-potable water reuse in a London context (for example see: Aitken et al., 2014; Hills et al., 2001; Smith et al., 2014), and therefore ecologically valid.

3.2. Impact of video messages

The results showed that participants were engaged by the video messages and that some aspects of some participants' attitudes changed over time, depending on the group they were assigned to. For the valid sample of matched pairs (441), the changes in attitude scores (summated question items for each dependent variable for each participant) for the four video message groups were compared with the control group to evaluate the impact of watching the videos. Firstly Pearson's Chi-Square tests showed that there were no statistically significant differences between the distribution of demographic characteristics of the five groups for gender ($\chi^2 = 2.996$, $df = 4$, $p = 0.559$), age ($\chi^2 = 14.893$, $df = 20$, $p = 0.783$) ethnicity ($\chi^2 = 25.820$, $df = 16$, $p = 0.057$), annual income ($\chi^2 = 21.256$, $df = 20$, $p = 0.382$) or level of education ($\chi^2 = 47.159$, $df = 40$, $p = 0.203$). As such, no intra-group weighting adjustments were made before comparing the five groups.

Comparing the video messages to the control group showed both the compliance message and the general messages had statistically significant improvements for some attitude measurements. Results from the one-way ANOVA (Table 3) on gain scores showed significant interactions for four of the five dependent variables with small effects sizes ($\eta^2 > 0.02$). Follow-up Dunnett's t-tests showed statistically significant improvements for the general message group when compared with the control group for the support ($p = 0.026$) and trust ($p = 0.042$) variables. The results showed statistically significant improvements for the compliance group when compared to the control group for acceptance ($p = 0.015$), support ($p = 0.031$) and risk perceptions ($p = 0.025$). Due to significant variation in the attrition rate between age groups from T_1 to T_2, the effect of age as a covariate was evaluated using ANCOVA. These results showed no change in the effect sizes for the five dependent variables (Table 3).

3.2.1. Message comprehension and impact

The results for each message group were explored to see how well the messages were understood by participants. In all cases, a high proportion of participants (>90%) agreed with the statement "the message was easy to understand", with the highest agreement (97%) in the general message group. The comprehension results showed that participants responded to the water safety attribute frame manipulations. Comparing the responses from the four groups watching a video showed that the proportion selecting the appropriate statement was highest in the anticipated group: *"the video helped me understand about water quality compliance"* was significantly higher in the water quality compliance group ($\chi^2 = 21.10$, $df = 3$, $p = 0.001$); *"the video helped me understand about comparing every-day risks"*, was significantly higher in the relative risk group ($\chi^2 = 48.80$, $df = 3$, $p = 0.001$); and *"the video helped me understand about water treatment technology"*, was significantly higher in the technology group ($\chi 2 = 22.06$, $df = 3$, $p = 0.001$).

The results for each message group were examined individually to determine how the dependent variables changed over time. In the no message group, there was evidence that the strength of acceptance decreased with paired-samples t-tests showing a statistically significant decrease in levels of acceptance ($t(90) = 2.319$, $p = 0.023$) and support ($t(90) = 2.068$, $p = 0.041$). Further inspection of this result showed that these changes were largely due to the participants moving from 'strongly agree' to 'agree' and particularly for the lower exposure uses of toilet flushing and garden watering and industry use. In the general message group, paired-samples *t*-

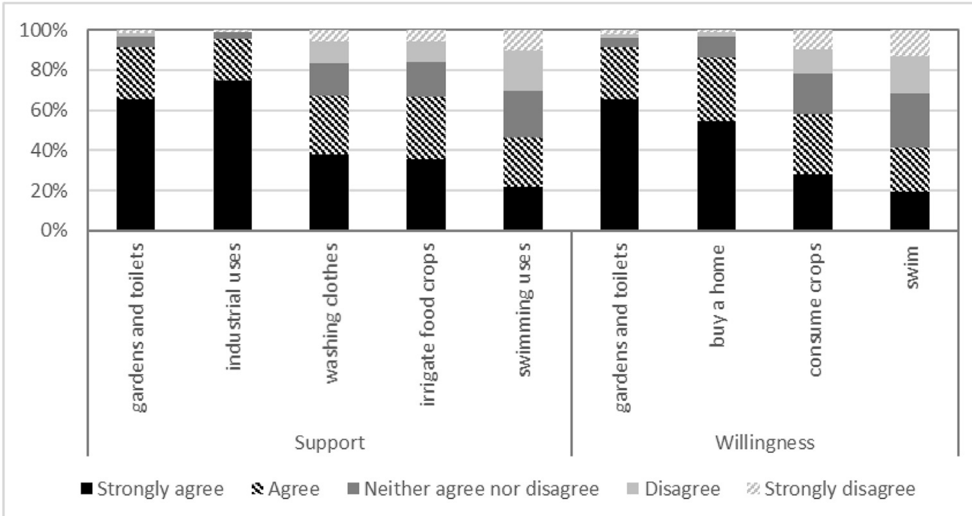

Fig. 3. Proportion of participants agreeing to statements asking for their support and behavioural intentions (willingness) towards the use of recycled water (441).

Table 3
Results for five dependent variables and five groups for pre and post surveys.

Dependent variable	Time	No Message	General	Comply	Relative Risk	Tech.	ANOVA	ANCOVA (age as covariate)
Acceptance	T_1	35.63 (7.59)	36.01 (6.38)	36.03 (7.03)	35.77 (6.96)	35.73 (6.26)	F (4, 432) = 2.509, p = 0.041, η2 = 0.023	F (4, 432) = 2.512, p = 0.041, η2 = 0.023
	T_2	34.45 (7.83)	36.47 (6.44)	36.90 (5.94)	35.53 (7.78)	35.92 (6.49)		
Support	T_1	20.14 (4.14)	20.06 (3.82)	20.27 (3.98)	20.16 (3.76)	20.23 (3.57)	F (4, 433) = 2.502, p = 0.042, η2 = 0.023	F (4, 433) = 2.525, p = 0.042, η2 = 0.023
	T_2	19.49 (4.28)	20.53 (3.69)	20.75 (3.22)	20.08 (4.19)	20.38 (3.49)		
Willingness (behavioural intentions)	T_1	15.48 (3.70)	15.83 (3.05)	15.75 (3.26)	15.60 (3.45)	15.50 (2.96)	F (4, 434) = 1.476, p = 0.209, η2 = 0.013	F (4, 434) = 1.473, p = 0.209, η2 = 0.013
	T_2	14.96 (3.87)	15.92 (2.95)	16.10 (3.15)	15.45 (3.84)	15.54 (3.28)		
Risk	T_1	23.00 (4.40)	23.26 (3.75)	22.86 (4.65)	23.31 (3.70)	23.22 (3.45)	F (4, 432) = 2.519, p = 0.041, η2 = 0.023	F (4, 432) = 2.589, p = 0.036, η2 = 0.023
	T_2	22.62 (4.20)	23.62 (3.70)	23.72 (4.01)	23.26 (3.67)	22.92 (3.43)		
Trust	T_1	25.65 (5.51)	25.71 (4.89)	26.27 (5.33)	26.46 (4.46)	26.09 (4.90)	F (4, 435) = 2.644, p = 0.033, η2 = 0.024	F (4, 435) = 2.619, p = 0.035, η2 = 0.024
	T_2	25.47 (5.50)	26.77 (4.53)	26.88 (4.98)	26.53 (4.43)	25.80 (4.74)		

Mean values with SD in parenthesis – calculated from the aggregate question items for each participant.

test results showed a significant positive change in trust ($t(86) = -2.833$, $p = 0.006$). Finally, in the water quality compliance group, paired-samples t-tests showed a significant positive change in risk perceptions ($t(79) = -2.567$, $p = 0.012$).

3.2.2. London weighting

Weighting cases so that the proportions were equivalent to the London population for age, gender, ethnicity, level of education, resulted in only the risk perception variable showing a significant interaction for the one-way ANOVA comparing the five message groups ($F(4,393) = 3.550$, $p = 0.007$, $\eta^2 = 0.034$). Neither acceptance ($F(4,392) = 0.636$, $p = 0.637$), support ($F(4,392) = 0.744$, $p = 0.563$), behavioural intentions ($F(4,392) = 0.338$, $p = 0.852$) or the trust variable ($F(4,396) = 0.938$, $p = 0.442$) resulted in significant interactions.

3.3. Comparisons between message groups

The results above show that, when the groups are examined individually, the general message and the compliance message appeared to have the greatest impact on respondents, as evidenced by changes in dependent variables (trust and risk perceptions). However, in order to better assess framing effects – i.e. the role of the three message frames, as opposed to the general message – we also compared the four message groups to each other (H2). One-way ANOVA showed a significant interaction for the trust variable ($F(3,345) = 2.919$, $p = 0.034$, $\eta^2 = 0.025$) and there was some indication of an interaction for risk perceptions with a small effects size ($F(3,342) = 2.521$, $p = 0.056$, $\eta^2 = 0.022$). The interactions were followed up using Tukey's post-hoc test to explore which groups were different. This showed that there was no significant difference between the compliance message group and the general (context) message group. However, both the compliance message and the general messages performed better than the technology message, which provides some evidence of a negative framing effect from the technology message.

It was hypothesised (H3) that there would be an interaction between the video message groups based on participants' initial levels of support for using recycled water for swimming areas – particularly as there were high proportions of participants initially not supportive or neutral on this type of use. However, although there were significant differences between how the attitudes changed in these three initial support categories, two-way ANOVA did not reveal a significant interaction with the video message groups. The interaction was the strongest with the trust variable ($F (2, 353) = 1.959$, $p = 0.071$, $\eta^2 = 0.032$) and weakest for risk perceptions ($F (2, 354) = 1.263$, $p = 0.274$, $\eta^2 = 0.021$). Inspection of the marginal means showed that the strongest positive changes were for the participants in the compliance message group ($n = 30$) for the acceptance, support and risk perception variables for those who were initially not supportive, however, there was no evidence of a statistically significant framing effect.

Considering the demographic variables of gender and age, the only near-significant interaction (with a medium partial eta squared effect size > 0.06) to emerge was for risk perceptions for the two-way ANOVA of message group and age category ($F (12,330) = 1.761$, $p = 0.054$, $\eta^2 = 0.060$). The follow up simple effects test (with Bonferroni corrections) showed statistically significant differences only for the youngest age group category (18–34) where participants perceived less risk in the compliance message group compared with the technology message group (mean difference = 2.635, $p = 0.025$). All other differences between the groups were less and not statistically significant for all other age categories. Whilst these differences were observed, it is noted that there were small numbers of participants within the age group categories of each video message group.

Based on these analyses, the following summation of message impacts and framing effects is put forward (Table 4). The overall picture that emerged was that the general (context) message and the water quality compliance message had more impact on participants. In contrast with the general (context) message (and to some degree the compliance message), the water treatment technology focal characteristic may have reduced the potential for the messages to have a positive impact on the participants' attitudes.

3.3.1. *London weighting*

Weighting cases so that the proportions were equivalent to the London population for age, gender, ethnicity, level of education, resulted in only the risk perception variable showing a significant interaction for the one-way ANOVA comparing the four video groups ($F (3, 309) = 4.680$, $p = 0.003$, $\eta^2 = 0.043$). Neither acceptance ($F (3,296) = 0.654$, $p = 0.581$), support ($F (3, 297) = 0.591$, $p = 0.621$), behavioural intentions ($F (3,300) = 0.447$, $p = 0.720$) or the trust variable ($F (3, 300) = 1.239$, $p = 0.296$) resulted in significant interactions. On inspection of the Tukey post-hoc test results for the risk perception interaction, both the general message ($p = 0.020$) and the compliance message ($p = 0.018$) had statistically significant improvement when compared to the technology message. The interactions with age and gender categories were also explored using two-way ANOVA. As with the unweighted sample, there was a significant interaction between age categories and message group for risk perceptions ($F (12,349) = 2.355$, $p = 0.006$, $\eta^2 = 0.075$) and, through inspection of the marginal means and simple effects tests, a similar pattern of results emerged as with the unweighted sample.

4. Discussion

In this study, we investigated the impact of video messages and message framing on participants' attitudes to non-potable recycled water. Findings demonstrate that participants were engaged by the video messages and that some aspects of some participants' attitudes did change over time - depending on the group they were assigned to. Comparing the video messages to the control (no message) group showed that both the general (context) message and the water quality compliance messages resulted in improvements for some attitude measurements. The impact was more pronounced in terms of decreasing perceptions of risk and increasing trust in management. However, results from the comparisons between groups showed that, for the compliance message, it is difficult to ascertain whether the added compliance frame had any impact over and above that of the general message. Following weighting of the sample to match demographic proportions in the London population, the results pointed to implications for improving risk perceptions in the younger age groups (with the difference in results also highlighting limitations to the method of participant recruitment and perhaps some ecological but limited external validity). The results supported previous findings of positive impacts from information provision about recycled water safety (Fielding and Roiko, 2014) and also add to the literature on the inter-related nature of lower risk perceptions, higher trust and higher acceptance (Fielding et al., 2018). The results are encouraging in that they support the use of video animations for engaging the public with water recycling and for reducing perceptions of risk. However, as the mechanism of communication (video animations) was not variable, there is no evidence to suggest that videos were

Table 4
Results summarised as a preliminary typology of message impact and framing effects.

Context frame	Attribute frame	Message impact	Framing effect
Water supply context, water reuse as a solution with benefit from sustaining water supplies but with risks from contaminants	None (general message)	Helped participants understand about recycled water. Gains in trust. Impact on support and trust compared with control group.	Gains in trust and less perceived risk compared with the technology message (particularly for the youngest age group)
	Water quality compliance	Helped participants understand about water quality compliance. Less risk perceived. Impact on acceptance, support and risk perceptions when compared with control group.	No difference to the general message. Indication of less perceived risk for those initially not supportive, and in the youngest age group, particularly compared to the technology message.
	Relative risk	Helped participants understand about comparing every-day risks. No impact on attitudes compared to the control group.	No difference to the general message.
	Technology selection	Helped participants understand about water treatment technology. No impact on attitudes compared to control.	Less trust compared to general message. Indication of more perceived risk compared to the compliance message, particularly in the youngest age group category.
No message		Some decline in acceptance and support for those initially more supportive of the low exposure uses (e.g. toilet flushing)	

necessarily any better than other forms of communication (e.g. website, pamphlet).

The results indicate a link between the provision of the video animation messages and trust building. The general message (which framed the role of recycled water in the context of London's water resource management) improved overall trust. This improvement in trust is notable as previous studies have qualitatively highlighted a lack of trust in water safety as limiting people's willingness to used non-potable recycled water (Roseth, 2008). Whilst a number of previous studies have shown an increase in trust in authorities to manage recycled water schemes following the receipt of information (Price et al., 2015; Roseth, 2008), these results were largely focused on potable reuse. The findings of this study extend that trend to a broad palette of non-potable reuse possibilities. More generally, as trust building is considered fundamental for promoting water reuse, including in London (Khan and Gerrard, 2006; Aitken et al., 2014), some improvement in trust from viewing the video messages is encouraging.

There was little indication that the relative risk message impacted on attitude change. Previous research has found that providing context on the relatively low risk of recycled water for drinking, compared to other every-day risks, can lower risk perceptions and improve public support (Price et al., 2015). In contrast, earlier work found that this kind of information may decrease a message's impact (Fielding and Roiko, 2014). The findings of this study are more in keeping with the latter. Similarly, the decrease in the general acceptance observed in the group that was not exposed to any messaging is consistent with others that have found decreases in support associated with no information provision (Fielding and Roiko, 2014; Roseth, 2008). It has been argued that public acceptance can wane if engagement efforts are underwhelming (Russell et al., 2008). The results of this study support this claim and also suggest benefits to exploring how information might engage more deeply with the public's understanding of the relative risks of using recycled water (also within the context of *de-facto* reuse - Smith et al., 2018). Whilst being mindful of methodological limitations, the results showed that providing some information was important for maintain positive attitudes towards less contentious uses as well as potentially strengthening support for more contentious uses.

The value of separating different focal characteristics of water safety messaging was particularly evidenced by the results for the water treatment technology frame, which showed some evidence of a negative framing effect (compared to the compliance message and the general message). Whilst previous studies have shown that information about water recycling technology can have positive impacts (Roseth, 2008; Dolnicar et al., 2010), findings from this study suggest some caution should be taken before pursuing this type of messaging. An explanation may be that those already comfortable with water reuse technology, or those who are very *un*comfortable with it, are unlikely to be influenced by more of this type of information (de Koster and Achterberg, 2015). Results of this study indicate that people may be more receptive to information focusing on the general context or on the management practices that facilitate water quality compliance, rather than the ability of water treatment processes to remove contaminants from wastewater.

The findings presented here provide a platform for exploring attitude change in more detail, and further research is recommended to develop and apply the proposed message framing typology and build on evidence of framing effects relating to specific types of non-potable recycled water use in different communities. There is a particular need to examine effects on attitudes towards more contentious uses where initial attitudes may be more entrenched and difficult to shift (as reflected in the results to H3). It is also important to explore the stability of attitudes over longer time periods. There are opportunities for developing targeted messages, and more so, for involving the public to help co-construct frames that can help target specific concerns of different groups within the community (Hallahan, 1999; Mankad, 2012). Thus, the findings indicate feasible benefits to developing approaches that support more interactive, on-going frame development processes that aim to negotiate different points of view and expectations (Dewulf et al., 2009). Finally, whilst this study's findings are encouraging in that they found some impact from messages, these were modest impacts. There is potential in this form of communication, but no single message frame will ever be a panacea for enhancing support of recycled water, and practitioners should always be mindful of the need to develop such communications as one part of more comprehensive engagement strategies to achieve more meaningful shifts in public attitudes (Smith et al., 2018).

5. Conclusions

This study aimed to examine the impact of message framing on public attitudes towards non-potable water reuse through the use of video messages that selectively communicated information regarding the safety of non-potable recycled water use in London. The research provides evidence to show that the purposeful selection and emphasis of certain focal characteristics of a message has the potential to influence participants' attitudes to recycled water. In particular, findings illustrate the positive impact of communications which are framed in terms of compliance with water quality requirements. On the other hand, there was no evident impact from messages framed around the ability of water treatment technologies to remove contaminants nor in terms of non-potable water risks relative to other every-day risks. Through the conceptualisation of a message framing typology, this study advances understanding of public responses to information and provides an avenue for improving communication around reuse schemes. The corroboration of benefits to communicating about recycled water safety within the water resource context is of considerable benefit to water industry practitioners developing public engagement information.

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References

Aitken, V., Bell, S., Hills, S., Rees, L., 2014. Public acceptability of indirect potable water reuse in the south-east of England. Water Sci. Technol. Water Supply 1–11. https://doi.org/10.2166/ws.2014.051.
Ajzen, I., 2001. Ature and. Annu. Rev. Psychol. 52, 27–58. https://doi.org/10.1146/annurev.psych.52.1.27.
Arvai, J., Louie, R.I., 2014. Effective Risk Communication. Routledge, Abingdon, Oxon.
Bell, S., Aitken, V., 2008. The socio-technology of indirect potable water reuse. Water Sci. Technol. Water Supply 441–448. https://doi.org/10.2166/ws.2008.104.
Bruvold, W.H., 1988. Public Opinion on water reuse options. J. Water Pollut. Control Fed. 60, 45–49.
Buyukkamaci, N., Alkan, H.S., 2013. Public acceptance potential for reuse applications in Turkey. Resour. Conserv. Recycl. 80, 32–35. https://doi.org/10.1016/j.resconrec.2013.08.001.
Castell, S., Charlton, A., Clemence, M., Pettigrew, N., Pope, S., Quigley, A., Navin Shah, J., Silman, T., 2014. Public Attitudes to Science 2014. Ipsos MORI Social Reserach Institute, London.

Cortina, J.M., 1993. What is coefficient alpha? An examination of theory and applications. J. Appl. Psychol. 78, 98–104. https://doi.org/10.1037/0021-9010.78.1.98.
Dainton, M., 2004. Explaining theories of Persuasion. In: Dainton, M., Zelley, E. (Eds.), Applying Communication Theory for Professional Life: a Practical Introduction. SAGE Publications Ltd, London, pp. 103–131.
de Koster, W., Achterberg, P., 2015. Comment on "Providing information promotes greater public support for potable recycled water" by Fielding, K.S. and Roiko, A.H., 2014 [Water Research 61, 86-96. Water Res. 84, 372–374. https://doi.org/10.1016/j.watres.2015.05.067.
de Vaus, D.A., 2002. Surveys in Social Research, fifth ed. Allen and Unwin, Crows Nest, NSW, Australia.
DESSIN, 2017. Video: DESSIN Sewer Mining Easily Explained. https://dessin-project.eu/?p=2232. (Accessed 5 March 2017).
Dewulf, A., Craps, M., Bouwen, R., Taillieu, T., Pahl-Wostl, C., 2005. Integrated management of natural resources: dealing with ambiguous issues, multiple actors and diverging frames. Water Sci. Technol. 52, 115–124.
Dewulf, A., Gray, B., Putnam, L., Lewicki, R., Aarts, N., Bouwen, R., van Woerkum, C., 2009. Disentangling approaches to framing in conflict and negotiation research: a meta-paradigmatic perspective. Hum. Relat. https://doi.org/10.1177/0018726708100356.
Dolnicar, S., Hurlimann, A., Duc, L., 2010. The effect of information on public acceptance: the case of water from alternative sources. J. Environ. Manag. 91, 1288–1293. https://doi.org/10.1016/j.jenvman.2010.02.003.
Dolnicar, S., Hurlimann, A., Grün, B., 2014. Branding water. Water Res. 57, 325–338. https://doi.org/10.1016/j.watres.2014.03.056.
Dolnicar, S., Hurlimann, A., Grün, B., 2011. What affects public acceptance of recycled and desalinated water? Water Res. 45, 933–943. https://doi.org/10.1016/j.watres.2010.09.030.
Dolnicar, S., Schäfer, A.I., 2009. Desalinated versus recycled water: public perceptions and profiles of the accepters. J. Environ. Manag. 90, 888–900. https://doi.org/10.1016/j.jenvman.2008.02.003.
Entman, R.M., 1993. Framing: toward clarification of a fractured paradigm. J. Commun. 43, 51–58. https://doi.org/10.1111/j.1460-2466.1993.tb01304.x.
Escobar, M.P., Demeritt, D., 2014. Flooding and the framing of risk in British broadsheets, 1985-2010. Publ. Understand. Sci. (Bristol, England) 23 (2000), 454–471. https://doi.org/10.1177/0963662512457613.
European Commission, 2016. Guidelines on Integrating Water Reuse into Water Planning and Management in the Context of the WFD. European Commission, Brussels.
Fielding, K.S., Dolnicar, S., Schultz, T., 2018. Public acceptance of recycled water. Int. J. Water Resour. Dev. 627, 1–36. https://doi.org/10.1080/07900627.2017.1419125.
Fielding, K.S., Roiko, A.H., 2014. Providing information promotes greater public support for potable recycled water. Water Res. 61, 86–96. https://doi.org/10.1016/j.watres.2014.05.002.
Friedler, E., Lahav, O., Jizhaki, H., Lahav, T., 2006. Study of urban population attitudes towards various wastewater reuse options: Israel as a case study. J. Environ. Manag. 81, 360–370.
Frijns, J., Smith, H.M., Brouwer, S., Garnett, K., Elelman, R., Jeffrey, P., 2016. How governance regimes shape the implementation of water reuse schemes. Water (Switzerland) 8. https://doi.org/10.3390/w8120605.
GLAIntelligence, 2016. GLA 2015 round Trend-based Projections - Results. Greater London Authority, London.
Goodwin, D., Raffin, M., Jeffrey, P., Smith, H.M., 2017. Evaluating media framing and public reactions in the context of a water reuse proposal. Int. J. Water Resour. Dev. Under revi.
Hallahan, K., 1999. Seven models of framing: implications for public relations. J. Publ. Relat. Res. 11, 205–242. https://doi.org/10.1207/s1532754xjprr1103_02.
Hambly, a. C., Henderson, R.K., Baker, a., Stuetz, R.M., Khan, S.J., 2012. Cross-connection detection in Australian dual reticulation systems by monitoring inherent fluorescent organic matter. Environ. Technol. Rev. 1, 67–80. https://doi.org/10.1080/09593330.2012.696724.
Harris-Lovett, S., Binz, C., Sedlak, D.L., Kiparsky, M., Truffer, B., 2015. Beyond user acceptance: a legitimacy framework for potable water reuse in California. Environ. Sci. Technol. 49, 7552–7561. https://doi.org/10.1021/acs.est.5b00504.
Hills, S., Smith, a., Hardy, P., Birks, R., 2001. Water recycling at the millennium dome. Water Sci. Technol. 43, 287–294.
Hurlimann, A., Dolnicar, S., 2016. Public acceptance and perceptions of alternative water sources : a comparative study in nine locations. Int. J. Water Resour. Dev. 32, 650–673. https://doi.org/10.1080/07900627.2016.1143350.
Hurlimann, A., Dolnicar, S., 2010. When public opposition defeats alternative water projects - the case of Toowoomba Australia. Water Res. 44, 287–297. https://doi.org/10.1016/j.watres.2009.09.020.
Hurlimann, A., Dolnicar, S., Meyer, P., 2009. Understanding behaviour to inform water supply management in developed nations - a review of literature, conceptual model and research agenda. J. Environ. Manag. 91, 47–56. https://doi.org/10.1016/j.jenvman.2009.07.014.
Ishii, S.K.L., Boyer, T.H., 2016. Student support and perceptions of urine source separation in a university community. Water Res. 100, 146–156. https://doi.org/10.1016/j.watres.2016.05.004.
Islam, A., Sakakibara, H., Karim, R., Sekine, M., 2015. Evaluation of risk communication for rural water supply management: a case study of a coastal area of Bangladesh. J. Risk Res. 14, 1237–1262. https://doi.org/10.1080/13669877.2011.574315.
Jeffrey, P., Jefferson, B., 2003. Public receptivity regarding "in-house" water recycling: results from a UK survey. Water Sci. Technol. Water Supply 3, 109–116.
Khan, S.J., Gerrard, L.E., 2006. Stakeholder communications for successful water reuse operations. Desalination 187, 191–202. https://doi.org/10.1016/j.desal.2005.04.079.
Krantz, S.A., Monroe, M.C., 2016. Message framing matters: communicating climate change with forest landowners. J. For. 114, 108–115.
Krosnick, J.A., Alwin, D.E., Krosniek, J.A., 1989. Aging and susceptibility to attitude change. J. Pers. Soc. Psychol. 57, 416–425. https://doi.org/10.1037/0022-3514.57.3.416.
Krosnick, J.A., Petty, R.E., 1995. Attitude Strength: Antecedents and Consequences. Psycology Press, New York.
Lee, H., Tan, T.P., 2016. Singapore's experience with reclaimed water: NEWater. Int. J. Water Resour. Dev. 32, 611–621. https://doi.org/10.1080/07900627.2015.1120188.
Leong, C., 2016. The role of emotions in drinking recycled water. Water 8, 548. https://doi.org/10.3390/w8110548.
Leong, C., 2010. Eliminating " yuck ": a simple exposition of media and social change in water reuse policies. Int. J. Water Resour. Dev. 26, 111–124. https://doi.org/10.1080/07900620903392174.
Levin, I.P., Schneider, S., Gaeth, G., 1998. All frames are not created equal: a typology and critical analysis of framing effects. Organ. Behav. Hum. Decis. Process. 76, 149–188. https://doi.org/10.1006/obhd.1998.2804.
Lyytimaki, J., Assmuth, T., 2014. Down with the flow: public debates shaping the risk framing of artificial groundwater recharge. Geojournal 80, 113–127. https://doi.org/10.1007/s10708-014-9540-3.
Macpherson, L., 2014. Core Messages for Priority Contaminants of Emerging Concern. Water Research Foundation, Denver CO.
Macpherson, L., 2011. Talking about Water: Vocabulary and Images that Support Informed Decisions about Water Recycling and Desalination. WateReuse Research Foundation, Alexandria, VA.
Mainali, B., Ngo, H.H., Guo, W.S., Pham, T.T.N., Wang, X.C., Johnston, A., 2011. SWOT analysis to assist identification of the critical factors for the successful implementation of water reuse schemes. Desalin. Water Treat. 32, 297–306. https://doi.org/10.5004/dwt.2011.2714.
Mankad, A., 2012. Decentralised water systems: emotional influences on resource decision making. Environ. Int. 44, 128–140. https://doi.org/10.1016/j.envint.2012.01.002.
Marks, J., Martin, B., Zadoroznyj, M., 2008. How Australians order acceptance of recycled water: national baseline data. J. Sociol. 44, 83–99. https://doi.org/10.1177/1440783307085844.
Matos, C., Friedler, E., Monteiro, A., Rodrigues, A., Teixeira, R., Bentes, I., Varajao, J., 2014. Academics perception towards various water reuse options: university of Tras-os-Montes e Alto-Douro - UTAD Campus (Portugal) as a case study. Urban Water J. 11, 311–322. https://doi.org/Doi 10.1080/1573062x.2013.775314.
Menegaki, A.N., Mellon, R.C., Vrentzou, A., Koumakis, G., Tsagarakis, K.P., 2009. What's in a name: framing treated wastewater as recycled water increases willingness to use and willingness to pay. J. Econ. Psychol. 30, 285–292. https://doi.org/10.1016/j.joep.2008.08.007.
Motion, J., Kearnes, M., 2014. Project Report Water Recycling and Media : Guidelines for Communication. Australian Centre for Water Recycling Excellence, Brisbane, Australia.
Nancarrow, B.E., Leviston, Z., Po, M., Porter, N.B., Tucker, D.I., 2008. What drives communities' decisions and behaviours in the reuse of wastewater. Water Sci. Technol. 57, 485–491. https://doi.org/10.2166/wst.2008.160.
Nancarrow, B.E., Leviston, Z., Tucker, D.I., 2009. Measuring the predictors of communities ' behavioural decisions for potable reuse of wastewater. Water Sci. Technol. 60, 3199–3210. https://doi.org/10.2166/wst.2009.759.
Nisbet, M.C., 2009. The ethics of framing science. Commun. Biol. Sci. Ethical Metaphor. Dimens. 51–73.
Norman, G., 2010. Likert scales, levels of measurement and the "laws" of statistics. Adv. Health Sci. Educ. 625–632. https://doi.org/10.1007/s10459-010-9222-y.
NRMMC, EPHC, AHMC, 2006. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1). Natural Resource Ministerial Management Council, Environment Protection and Heritage Council and Australian Health Ministers, Canberra.
Pan, Z., Kosicki, G., 1993. Framing analysis: An approach to news discourse. Polit. Commun. 10, 55–75. https://doi.org/10.1080/10584609.1993.9962963.
Po, M., Nancarrow, B.E., Leviston, Z., Porter, N.B., Syme, G.J., Kaercher, J.D., 2005. Water for a Healthy Country Predicting Community Behaviour in Relation to Wastewater Reuse. Canberra.
Poortinga, W., Pidgeon, N.F., 2003. Exploring the dimensinality of trust in risk reguation. Risk Anal. 23, 961–972.
Price, J., Fielding, K.S., Gardner, J., Leviston, Z., Green, M., 2015. Developing effective messages about potable recycled water: the importance of message structure and content. Water Resour. Res. 51, 2174–2187. https://doi.org/10.1002/2014WR016514.Received.
Roseth, N., 2008. Community Views on Recycled Water - the Impact of Information. Research Report 48. Salisbury, Australia.
Ross, V.L., Fielding, K.S., Louis, W.R., 2014. Social trust, risk perceptions and public acceptance of recycled water: testing a social-psychological model. J. Environ. Manag. 137, 61–68. https://doi.org/10.1016/j.jenvman.2014.01.039.
Rozin, P., Haddad, B., Nemeroff, C., Slovic, P., 2015. Psychological aspects of the rejection of recycled water: contamination, purification and disgust. Judgement Decis. Mak. 10, 50–63.

Russell, S., Lux, C., 2009. Getting over yuck: moving from psychological to cultural and sociotechnical analyses of responses to water recycling. Water Pol. 11, 21–35.
Russell, S., Lux, C., Hampton, G., 2008. Beyond "information": integrating consultation and education for water recycling initiatives. Soc. Nat. Resour. 22, 56–65. https://doi.org/10.1080/08941920801910666.
Simpson, J., Stratton, H., 2011. Talking about Water : Words and Images that Enhance Understanding. National Water Commission, Canberra.
Smith, H.M., Brouwer, S., Jeffrey, P., Frijns, J., 2018. Public responses to water reuse – understanding the evidence. J. Environ. Manag. 207, 43–50. https://doi.org/10.1016/j.jenvman.2017.11.021.
Smith, H.M., Rutter, P., Jeffrey, P., 2014. Public perceptions of recycled water: a survey of visitors to the London 2012 Olympic Park. J. Water Reuse Desalin 1–7. https://doi.org/10.2166/wrd.2014.146.
Tang, Z., Zhang, L., Xu, F., 2015. Examining the role of social media in California's drought risk management in 2014. Nat. Hazards 79, 171–193. https://doi.org/10.1007/s11069-015-1835-2.
USEPA, 2012. Guidelines for Water Reuse. United States Environmental Protection Agency, U.S. Agency for International Development, Washington, D.C.
Van Gorp, B., 2007. The constructionist approach to framing: Bringing culture back in. J. Commun. 57 (1), 60–78. https://doi.org/10.1111/j.1460-2466.2006.00329.x.
Van Selm, M., Jankowski, N.W., 2006. Conducting online surveys. Qual. Quantity 40, 435–456. https://doi.org/10.1007/s11135-005-8081-8.
WateReuse, 2014. The Ways of Water. www.watereuse.org/water-reuse-101/watereuse-videos/. (Accessed 10 August 2015).
Wester, J., Timpano, K.R., Cek, D., Broad, K., 2016. The psychology of recycled water: factors predicting disgust and willingness to use. Water Resour. Res. 52, 3212–3226. https://doi.org/doi:10.1002/2015WR018340.
WRRF, 2010. The Psychology of Water Reclamation and Reuse: Survey Findings and Research Road Map. WRF-04-008. Alexandria, USA.
Wu, X., Dodgen, L.K., Conkle, J.L., Gan, J., 2015. Plant uptake of pharmaceutical and personal care products from recycled water and biosolids: a review. Sci. Total Environ. 536, 655–666. https://doi.org/10.1016/j.scitotenv.2015.07.129.

Informing public attitudes to non-potable water reuse – The impact of message framing

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