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Water Cognition and Cognitive Affective Mapping: Identifying Priority Clusters Within a Canadian Water Efficiency Community

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Abstract We often assume that researchers and decision-makers are rational beings reliant on hard data to determine the best policy. But individuals are also influenced by their experiences with their physical and social environments. How they perceive and interact with their environment is also important for decision-making. The brain processes these personal and professional experiences to generate the emotional responses and belief systems used to interpret environments. It is these brain-environment interpretation and coding, storage and recall functions that provide the different mental representations used for ongoing interactions with the world. Social psychologists, anthropologists, behavioural geographers and environmental sociologists have extensive theoretical and empirical mechanisms to investigate how this processing shifts from an individual level to the social level. It is this interplay between individuals' cognitive processing and emotion, along with group decision-making about water policy, that is the basis for a water cognition framework. How to test and evaluate a water cognition framework is the challenge. Cognitive affective mapping (CAM)—as both a process and product—offers one possible mechanism. Cognitive affective maps (CAMs) can be used for data collection, analysis and a communication medium. These roles allow the researcher to articulate individuals' deep emotions and values within a water community or network. The design and process can reveal how a community's values, beliefs and norms have changed over time and what potential exists for addressing embedded innovation barriers within a water governance context. To explore these ideas, this paper includes a brief review of the evolving cognitive affective sciences literature as the basis for the water cognition framework, a methodology description of cognitive affective mapping and discussion of results from a Canadian water efficiency community.

Keywords Affect · Barriers-to-implementation · Beliefs · Canada · Cognitive science · Decision-making · Water efficiency · Emotion · Governance · Knowledge management · Pro-environmental behaviour · Water · Water cognition

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1 Introduction

We often assume that researchers and decision-makers are rational beings reliant on hard data to determine the best policy (Krantz and Kunreuther 2007; Pahl-Wostl et al. 2007). But individuals are also deeply influenced by their experiences with their physical and social environments (Rilling 2008; Chiao 2009; Gifford 2008; Northoff 2010). How they perceive and interact with their environment—the brain's "bidirectional traffic between subject and environment (Northoff (2010:748)"—is important for decision-making (Herzog and Bosley 1992; Schwarz 2000; Loewenstein and Lerner 2003; Strang 2004; Hyung-il and Picard 2006; Strang 2006; Frantz et al. 2005; Corral-Verdugo et al. 2008; Krantz et al. 2008; Gibbs 2009; Mercer 2010).

It is these brain-environment functions—interpretation and coding, storage and recall—that provide the different mental representations used for ongoing interactions with the world (Franks 2010; Frijda 2010; Stets and Turner 2010). There are multiple explanations for how these interactions shift from an individual level to the social level (Frijda 2010; Stets and Turner 2010). It is this interplay between an individual's cognitive processing and emotion, along with group decision-making about water policy, that is the basis for a water cognition framework (Wolfe 2012).

How to test and evaluate a water cognition framework is the challenge. Cognitive affective mapping (CAM), as a methodological process, offers one possible mechanism. Cognitive affective maps (CAMs), as a product of that process, can be used for data collection, analysis and a communication medium. Both the process and the product allow a researcher to articulate participants' emotions relevant to their efforts within a water community or network. They can also reveal how individuals' or communities' values, beliefs and norms change over time and what potential exists for addressing innovation barriers within a water governance context.

To explore these ideas, this paper includes a brief review of the evolving cognitive affective sciences literature. This literature is explored in greater detail elsewhere (Wolfe 2012) but only briefly here. This offers a foundation for the water cognition framework from which to test the method and a first case study. The methods, including a description of cognitive affective mapping, are discussed in Section Three. Section Four is a discussion of results from a Canadian water efficiency community, and Section Five provides conclusions and suggestions for future research.

2 A Water Cognition Framework

2.1 A Foundation in Cognitive and Affective Science

Cognitive science research—i.e., studies of the brain's nature and function—draws from philosophers, computer scientists, psychologists, linguists, and anthropologists' perspectives (Boden 2006). The affective sciences subfield—i.e., studies of emotion or 'affect'—indicates that brain structure helps to determine how an emotion is created, expressed and recognized. Emotion organizes and structures the brain (LeDoux 1996) because of its role in managing physical and social environmental signals (Franks 2010). The brain receives, selects, processes, edits and interprets information received from the surrounding environment. This information is then projected upon the world, manifest as belief systems, societal norms and customs (Franks 2010). Affective science also suggests that many decisions at both the individual and collective levels cannot be understood without exploring emotional variability, availability and coherence. Only by considering affect will both intuitive and analytical processes be evident—and recognized for their influence—in decision-making activities (Thompson and Mintzes 2002; Thagard 2006; Fontaine et al. 2007; Chiao 2009; Engelen et al. 2009; Brun et al. 2010; Frijda 2010; Northoff 2010).

The *variability* emerges from the specific emotional responses generated across multiple brain areas. These include the neocortex, insular, hippocampus, amygdala and midbrain (Franks 2010). Brain-generated emotions vary along multiple dimensions (Lerner and Keltner 2000; Scherer 2005; Fontaine et al. 2007; Kagan 2007; Engelen et al. 2009). For example, emotional variability may be evaluated along the two dimensions of valence and intensity. Valence is the characteristic of being pleasant or unpleasant and relates to dopamine release within the brain. Emotional intensity is subject to neural firing rates between synapses and conveys the degree of brain arousal involved in the emotional experience (Thagard 2006).

An emotion's *availability* is also important. When individuals exhibit a diminished ability to experience emotion—for example, individuals with brain damage or structural anomalies—their rational decision-making capacity is undermined (Damasio 1994; Damasio et al. 1994; Bechara et al. 2000; Lerner and Keltner 2000; Loewenstein and Lerner 2003; Bechara 2004; Lerner et al. 2004; Phelps 2006; Pessoa 2008). Results from artificial intelligence and neuroscience suggest that our human brains actually need emotion to be readily available if we are to make rational decisions. This means that the conventional bifurcation of the rational 'cold cognition' and the irrational 'hot cognition' is not physically possible or preferable (Zhu and Thagard 2002; Mériau et al. 2006; Thagard 2006; Panksepp 2010; Kahneman 2011).

Conscious decision-making is influenced by the reconciliation of priorities to generate emotional *coherence*. Coherence can be understood as "maximal satisfaction of multiple constraints (Thagard 2006:17–18)." Coherence in decision-making requires individuals to self-evaluate and infer the goals of others based on the variability criteria listed above. The acknowledgement of valence—for example, by recognizing a strongly preferred outcome at the self or group level—allows one to understand the roles of intuition, belief systems, and rationality in decision-making. Through this evaluative-action process, decisions are made at the individual or group level. An individual's, and eventually the group's, decision outcome is defined once an option with a strong positive emotional valence emerges and is agreed upon (Thagard and Kroon 2006; Smith and Mackie 2010; Fischer and Manstead 2010).

Combining emotional capacity—as expressed through variability and availability—and emotional coherence forms the foundation for an individual's beliefs and belief systems (Mercer 2010). A belief can be defined as "a proposition, or a collection of propositions, that one thinks is probably true (Mercer 2010:3)." Emotional beliefs are then extended and based on an "internally generated inference" where emotion is used as evidence (Fielder and Bless 2000:144). By drawing on one's emotional beliefs as evidence for truth, an individual may make "a generalization about an actor that involves certainty beyond evidence (Mercer 2010:1–2)." Emotional beliefs then become the foundation for our individual and group belief systems, expressed as our values and expectations, and directly in the form of our social norms and actions (Schwarz 2000; Mériau et al. 2006; Seymour and Dolan 2008; Frijda 2010; Norgaard 2011; see VBN theory in Koger and Du Nann-Winter 2010 for an alternative understanding of beliefs and values based in social psychology).

In contrast, rational choice theory suggests that decisions are based on complete knowledge, awareness of (dis)incentives, and an economic evaluation of outcomes (Lerner et al. 2004; Kahneman 2011). Yet despite the longevity and ubiquity of rational choice, cognitive science and psychology increasingly indicate that emotion is essential to both individual and group-level decision-making (Etzioni 1988; Finucane et al. 2000; Gaudine and Thorne 2001; Wild et al. 2001; Burke and Miller 1999; Cohen 2005; Holian 2006; Northoff 2010; Settle et al. 2010; Hatfield et al. 2009; Norgaard 2011). Therefore, analysis should be used to identify and recognize emotion for its fundamental influence on belief systems, internal identity and emotional coherence (Mercer 2010; Thagard 2006; Fischer and Manstead 2010; Smith and Mackie 2010).

2.2 Cognition and Emotional Beliefs in Water Governance

But how do these findings about cognition, emotional beliefs and decision-making relate to water governance and decision-making? This paper is an argument for using water cognition framework to explore water governance, with its diverse actors involved in programs, policies, and institutions. This framework can be used to examine how society's deep, and often unarticulated, ideas about water can converge, diverge, and change over time and space. This framework can focus specifically on the questions of why and how water research and policies evolve or respond to new challenges. A water cognition framework also allows us to examine the underlying, individual-to-group variables within conventional 'barriers to implementation' explanations (Rogers and Hall 2003; Brown and Farrelly 2007).

A water cognition framework is fully detailed elsewhere (Wolfe 2012). Briefly though, this framework considers variability, availability, and coherence within individual and group decision making associated with water resources and their management. It uses alternative methods to explore and generate a nuanced understanding of individuals' and groups' emotional belief systems and water decisions. The framework can be used to investigate new questions about aspects of water governance that are not yet fully articulated. For example, anthropology, sociology, social psychology and 'pro-environmental behaviour' researchers have explored individuals' beliefs and emotions related to water and environmental problems in general (Strang 2004; 2006; Linton 2010; Koger and Du Nann Winter 2010). However, we need to know more about whether and how beliefs and emotional intensities about certain key water concepts influence identities and vary across time and place. Most critically, how does emotional variability and availability at the individual level contribute to establishing coherence in institution-level water decision-making processes? Finally, what methodologies and metrics capture, express and convey this information for different audiences?

Understanding these cognitive factors can help researchers and policy makers create more effective programs, policies, regulations, and negotiations. This research agenda—a micro-level analysis of individuals' and groups' emotional beliefs associated with water resources—enriches the established explanations and quantitative data, used by engineers, economists and policy analysts. A method for exploring water cognition is presented below.

3 Methodology

3.1 Cognitive Affective Mapping

Cognitive affective mapping (CAM) is a process or procedure, developed by researchers in cognitive science and philosophy; the subsequent research data products are cognitive affective maps (CAMs) (Thagard 2010). The process and product maps can be used to identify concepts within an individual's worldview and illustrate the affective values assigned to various concepts. This form of visual data representation is easily accessible across disciplines, cultures, and professional perspectives. CAMs may then reveal and convey fundamental conflicts between individuals or across groups and track changes in emotional belief systems over time and place.

CAM studies may draw from multiple samples, time scales, or places. For example, participant samples might focus on individuals or groups at a single point or over time, possibly also comparing across gender or place, within a hierarchy, or across a management structure. It could compare individual or group emotional beliefs to a given water policy over time. The text data possibilities are also abundant. For example, text sources such as conference programs and proceedings, multi-level, semi-structured interviews with representatives of organizations, or official position statements and visioning briefs all represent viable data sources for the CAM method and water cognition studies.

To construct the CAMs, the data is coded to represent key concepts or beliefs with the associated affective (i.e., valence and intensity) values. In this way, CAMs differ from other mapping tools commonly used in the social sciences, such as social networks and mind maps (Valente 1996; Glaser 2006; Davis and Carley 2008; Wheeldon and Faubert 2009; Wolfe 2009). Unlike social networks, which identify and map individuals, CAMs identify and map concepts and beliefs within a set parameter. Mind maps identify affective-neutral concepts and their interrelationships. In contrast, CAMs indicate the affective values of concepts and beliefs, and explore how these affective values influences interrelationships and emotional coherence during a decision making process. The CAMs schematic is illustrated in Fig. 1.

In this schematic, geometric shapes are assigned to each element or node based on the concepts' valence. Ovals represent emotionally positive elements while hexagons represent emotionally negative elements. Rectangles represent elements that are affectively neutral or carry both positive and negative valence. A shape's line weight represents the intensity or relative strength of the associated positive or negative value.

Table 1 summarizes the map's components and the information types provided.

The links between each of the elements depict relations between them. Solid lines represent mutually supportive relations, i.e., the two concepts and their affective values do not conflict and may reinforce each other. Dashed lines represent incompatible relations between concepts and their affective values.

This process provides multiple advantages because constructing cognitive affective maps is relatively straightforward and the results easily shared in electronic or paper formats. Ideas can be represented and conveyed to others in an efficient, graphical form rather than in an extended narrative. For example, CAMs may be particularly useful in cross-cultural research to help overcome some language barriers and generate more nuanced responses to qualitative and potentially contentious research inquiries. This also allows individuals and groups to assess and revise the researcher's data interpretation before, during, or after the analysis.

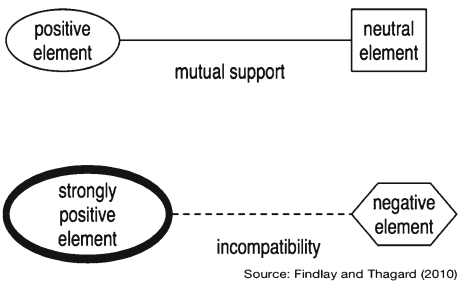

Fig. 1 Cognitive affective mapping schematic

Table 1 Components in cognitive affective maps

CAMs Components Used	Information Provided
Map represents….	cognitive content of an individual or group.
Nodes represent…	concepts.
Links indicate…	compatibility between concepts.
Emotional attributions represented by…	shapes and line widths.

The interface allows qualitative researchers to clarify their own implicit thinking and assumptions—thereby reducing the unavoidable bias, uncertainty and errors in the decision making process (Tversky and Kahneman 1974; Morewedge and Kahneman 2010)—by having participants verify the CAMs concepts and characteristics. Finally, CAM analysis provides a viable and transferable approach for identifying conflict, perceptual disconnects, and intervention opportunities within or across diverse communities. Because of this methodological, analytical, and communication potential, cognitive affective mapping processes will be useful for understanding water governance and its philosophies, policies, and programs. Cognitive affective maps, as the product of this research process, can then be used to compare, assess, and communicate the influence of emotion and belief systems on individual water decisions across different actors and groups.

3.2 Case Description of a Canadian Water Efficiency Assessment

In this study CAMs were used to evaluate participants' expressed emotional beliefs within an Ontario-based water efficiency practitioners' community. Water efficiency has conventionally been understood as a set of strategies used to increase water use efficiency and reduce consumption rates (Brooks 2006; Croke et al. 2007; Hoekstra and Chapagain 2007; Yilmaz et al. 2009). Water efficiency research most often focuses on the tools required (e.g., water rates and low-flow appliances) and the rationale for their use (e.g., efficiency incentives and reduced demand per use). Municipalities recognize the potential benefits of including water efficiency in their resource management plans (de Loë et al. 2001). Yet details about program evaluation and their results remain ambiguous. The research indicates water efficiency programs have mixed results but often vastly different metrics are measured, such as absolute water saved, the number of appliance rebates granted, capital or operating costs, or programs longevity and security (Waller and Scott 1998; de Oliver 1999; Brooks 2006). How to explain these mixed results, beyond just the established explanations or the usual 'barriers to implementation,' remains an open question.

While we have good explanations for the how, when, and where of water efficiency, we need to know more about why some water efficiency strategies work well and others do not. One option is to learn more about the practitioners who are responsible for implementing the policies and programs (Nancarrow et al. 1997; Singh et al. 2008; Ison et al. 2011). These individuals are likely to be trained as engineers or public communication specialists. They may be engaged in water efficiency, at least initially, because of a crisis or acute water scarcity, and may be working within a professional context that is only mildly supportive of water efficiency strategies (Allan 2003). But while many studies have explored consumers' reactions to water efficiency initiatives (Hamilton 1985; Thompson and Stoutemyer 1991; Pearce et al. 2010), only a few studies have examined the influence of decision makers' ability and willingness to adopt, implement, and sustain water efficiency initiatives (Sawyer

1983; de Young and Robinson 1984; Wolfe 2009). Recognizing participants' context, as well as their influences and contributions, provides critical information on how novel water management strategies are implemented or retained.

Investigating water efficiency concepts and belief systems from the practitioners' perspective provides valuable insights into water efficiency successes and failures. Practitioners are responsible for the design and implementation of policies and programs. Underlying their everyday decisions is a range of values, attitudes, norms, and knowledge about what constitutes a water problem and potential solution (Sewell and Burton 1971; Burmil et al. 1999; Corral-Verdugo et al. 2003). The cognitive affective sciences literature tells us that these practitioners' emotions and beliefs are actively reinforced by their acquisition and use of knowledge and by how their brains process social-environment interactions.

3.3 Data Collection

Using this confidential interview transcript data (2004–5) from earlier research (Wolfe 2008; Wolfe 2009), 31 interview requests were made from a non-random selection of the POLIS database of Canadian water efficiency professionals. Participants included representatives from federal and provincial organizations, municipal authorities, and other individuals (e.g., academic researchers). The response rate is discussed in the Data Results section.

During the initial study (2004–5), data were collected using a set of semi-structured questions administered using audio-recorded, in-person and telephone interviews, and email correspondence. Two question sets were used in every interview. The first set explored participants' education and professional training, including their water efficiency knowledge, along with his/her personal experiences with water scarcity. The second question set focused on participants' specific water efficiency responsibilities in their work, their experiences with policy or program implementation issues, and any strategies they used to resolve implementation issues.

In the subsequent study (2010–11), participants' belief systems were (re)explored with the cognitive affective mapping methodology. A single focus question—"what methods are most effective to get residential consumers to adopt and retain water efficient practices?"—was used to sift through the data. To answer the focus question, qualitative thematic analysis identified the concepts from archived, confidential interview data. These concepts were then assessed using indicators of participants' expressed affective characteristics of valence and intensity. The affective characteristics were derived from the audio and transcript data, e.g., the researcher's margin notes on participant body language during the interview, verbal indicators from the audio files, and adjectives used. Aggregated CAMs were then constructed, by hand and then in a word processing program, based on the identified concepts and their associated affective characteristics. The CAMs were analyzed through comparison of valence and intensity. The preliminary results suggested that there were two distinct sub-groups with emotional belief systems specific to the focus question.

A non-random selection of the 2004–5 study participants were then contacted and asked to review the draft CAMs. Each were asked to evaluate the sub-group draft CAMs based on whether the CAMs were accurate representations of 1) their own water efficiency-related worldview; 2) their perceptions of others' water efficiency worldviews; and, 3) a viable representation of the water efficiency community's worldview and priorities in general. Based on the assessments, minor adjustments were made to the draft CAMs and preliminary analysis. The revised and final CAMs are presented in the Discussion section below.

4 Discussion

4.1 Data Results

From thirty-one baseline requests that were emailed (2004), six requests (20 %) did not generate a response and twenty-five positive responses were received (80 %), which constitutes a very strong response rate for an in-depth qualitative design. One person requested electronic communication to complete the question sets. Twenty in-person interviews and four telephone interviews were completed. Eight participants had two or more interviews during the 2004–5 data collection period. The participants' professional affiliations are presented in Table 2.

The majority (64.5 %) of participants were employed in the public sector through provincial and municipal governments.

4.2 Data Analysis

Using the 2004–5 participant responses, the data collection and analysis was directed by the focus question of "what methods are most effective to get residential consumers to adopt and retain water efficient practices?" CAM nodes—according to the schematic set out in Fig. 1—were constructed around the expressed concepts, beliefs, and priorities related to water efficiency. Participants' affective responses—indicated by valence and intensity—were then attributed to each node.

From this data, participant responses were aggregated and clustered around two coherent and sub-group positions: behaviour-driven or technology-driven change. These clusters represented distinct positions on how practitioners believed water efficiency efforts should be prioritized, and how intensely—either positively or negatively—these beliefs were held.

The professional affiliations in the behaviour sub-group (Fig. 2) were primarily municipal water efficiency practitioners. The sub-group had a cognitive affective map that included a continuum of strongly positive, positive, and neutral attributions related to water efficiency concepts. There were no negative emotions.

The links—connecting the various concepts and emotional attributions—were compatible and reinforced the cognitive affective map's coherence. This suggests a sub-group with a well-established and coherent water efficiency understanding. Alternatively, this result could also be interpreted as a sub-group that is narrow in its outlook or understanding of water efficiency. Additional research would be required to assess which of these interpretations best applied.

Table 2 Ontario participants' professional affiliations

Professional Affiliation	Ontario Network (% of total)
Government Employee	3 (11.5 %)
Municipal Practitioner	13 (53 %)
Consultant/Private Sector	5 (19 %)
Academic	2 (9 %)
Local or Regional NGO	1 (4.5 %)
Other/Unknown	1 (4.5 %)
Total Number of Participants	25

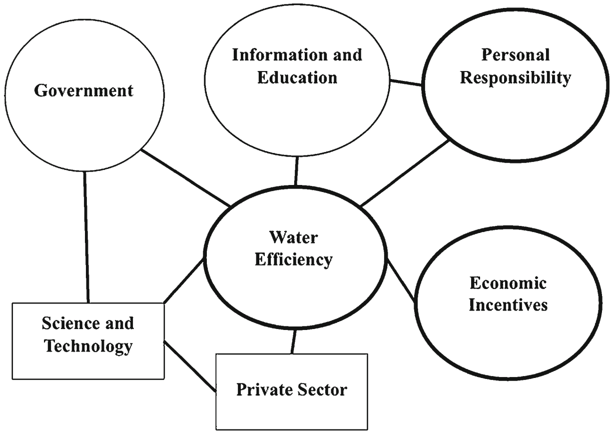

Fig. 2 Water efficiency through behaviour-driven change sub-group

This sub-group prioritized behavioural interventions aimed at consumers. Their expressed goal was to use behaviour interventions as a means to educate consumers and (re)connect their individual choices with cumulative water resource issues at the municipal scale. The preferred tools included informative billing, workshops or education programs, and appliance rebates. For example, financial rebates for toilets, showerheads, or washing machines provide consumers with funds when they remove or replace their old, inefficient water appliance with a designated water efficient model. However, the rebate programs are also designed to increase general awareness of water efficiency and to act as a relatively easy introduction to more challenging water efficiency elements

In contrast, the technology-driven change sub-group (Fig. 3) had a cognitive affective map that included strongly positive, positive, neutral, negative, and strongly negative emotional attributions related to water efficiency concepts.

Members of this sub-group professionally identified as water efficiency researchers or private sector consultants. Their expressed goal was to reduce absolute water demand amounts and show evidence of this reduction through quantifiable metrics. In this sub-

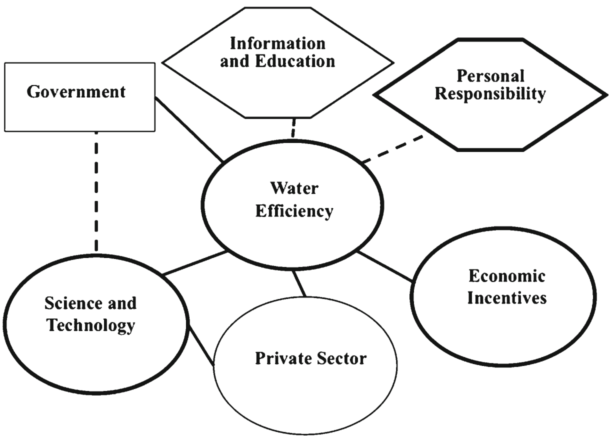

Fig. 3 Water efficiency through 'technology-driven change' sub-group

group, priority was given to technological advances and interventions such as low flow appliances, outside irrigation technology, and widespread installation and use of residential smart meters to monitor not only absolute demand but also the source, duration and time-of-use during a 24-hour cycle.

There were distinct differences between the sub-groups' beliefs about how to best get residential consumers to adopt water efficient practices. Table 3 shows the sub-groups' relative valance (i.e., positive, neutral or negative) and intensity (i.e., strength of emotion) to illustrate the importance of various water efficiency components.

Unsurprisingly, the sub-groups were strongly positive about the use of economic incentives to reduce water demand and use. Both groups—in fact, all participants—strongly endorsed the use of economic incentives through pricing signals, including increased water prices per cubic meter consumed or tariff restructure in general. The community's support for pricing signals was universal despite the research indicating inconsistent long-term impacts of water pricing on consumer behaviour (Dickerson et al. 1992; Harlan et al. 2009; Willis et al. 2011).

Beyond their shared belief about the value of economic incentives, the sub-groups varied on every other concept. For example, for the role of science and technology, the behaviour sub-group expressed a neutral attribution. This attribution reflects a recognition, if not enthusiasm, for the role technologies such as low-flow appliances or smart meters play in a water efficiency agenda. Not surprisingly, the technology-driven sub-group was strongly positive about scientific innovation and technological change. The potential influence and roles of government and the private sector also differed and reflect, perhaps, the professional affiliations most likely associated with each of the sub-groups' membership. Finally, the sub-groups varied on their beliefs about the potential power of water efficiency information and education to guide or direct consumer decisions and behavior.

Most interesting was how these results exposed the sub-groups' fundamental or philosophical differences. For example, each sub-group held strong, but divergent, beliefs about the residential consumer's role in a water efficiency agenda. The behaviour-subgroup believed the residential consumer to be amenable to economic incentives, receptive to information and education, and beneficiaries of water efficiency technology. In contrast, the technology-driven change sub-group felt strongly about prioritizing the use of economic incentives and technology and negatively viewed efforts to direct information and education at consumers. Overall, the sub-groups' perspectives on consumers and their personal responsibility for water efficiency varied significantly. For the behaviour-driven change sub-group, the consumer's personal responsibility—his or her potential roles and contributions—was essential to moving the water efficiency agenda forward and to achieving sustainability objectives in the long-term. For the technology-driven change sub-group,

Table 3 Water efficiency sub-group CAM comparison

Beliefs about water efficiency adoption	Behaviour Subgroup Values	Technology Subgroup Values
Importance of…		
Economic Incentives	Strongly Positive	Strongly Positive
Private Sector	Neutral	Positive
Government	Positive	Neutral
Science and Technology	Neutral	Strongly Positive
Information and Education	Positive	Negative
Personal Responsibility	Strongly Positive	Strongly Negative

consumers were considered to be almost counter-productive to the goal of absolute reduction in water demand and consumption numbers.

These assigned affective valances and intensities tell us significant things about the differing worldviews held by water efficiency practitioners. First, there is a fundamental disconnect within the larger community based on clustering and valuing of certain concepts. This research showed that even within a spatially limited water efficiency community, distinct sub-groups or populations could be identified. Second, the results suggested underlying tensions in the professional community influenced the research agenda. The community self-funds various research endeavours to advance the water efficiency agenda. The existence of these sub-groups and their differing priorities is a source of significant potential tension over whether to prioritize behavioural or technological research and investment. How this tension is resolved and the research trajectory agreed upon by the group has subsequent implications for group process, identity and what constitutes 'legitimate' water efficiency research or interventions.

This research provided insight on how individual preferences influence group decision-making about water. The individual-level emotional attribution to water concepts seemed to play a role in establishing priorities and decision-making for the group. This is possible, as emotional beliefs help to define priorities, which then beget self-identity, and then group-identity, as practitioners identify where they 'fit' with the different sub-groups. These identities then direct with whom one communicates and shares information, and reinforces a common language, norms, and priorities. This iterative interaction—based in emotional beliefs, priorities, identities and communication—helps to determine or reinforce one's professional social network, range of possible collaborators, and worldview. This can then sway the type of research supported or undertaken, the funding sought, and the programs implemented within the water efficiency community.

Finally, the extent to which sub-groups possess divergent affective attributions will determine the coherence of any water efficiency message conveyed to the larger water management community—individuals who may not know about or support a water efficiency agenda. The message coherence will inevitably influence perceptions of water efficiency overall.

5 Conclusion

Cognitive Affective Mapping is a useful tool for exploring and testing a water cognition framework. CAMs can address water problems by articulating emotional beliefs and values at the individual and group levels. They can be used to provide a nuanced and alternative understanding of entrenched 'barriers to implementation' explanations in water decision-making and policy. In the future, CAMs may be used to effectively facilitate negotiations across an ever-widening range of water governance actors. This type of water cognition research, by recognizing that emotional beliefs are essential for understanding water decision-making, will help explain water research and policy change over time, identify a new method for articulating challenges within decision-making, and suggest opportunities to address and remedy entrenched social challenges within water governance institutions and processes.

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