What’s in Your Body of Water? A Pilot Study Using Metaphoric Framing to Reduce the Psychological Distance in Pharmaceutical Pollution Risk Communication

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Abstract
Aquatic pharmaceutical pollution poses ecotoxicological risks to the environment and human health. Consumer pharmaceutical use and disposal behaviors represent a significant source of pharmaceutical compounds in surface waters, and communication strategies are needed to promote pro-environmental behaviors to reduce pharmaceutical pollution. Designing effective risk communication campaigns requires an understanding of public perceptions of aquatic pharmaceutical pollution. The purpose of this mixed-methods pilot study was to test the efficacy of using theories from cognitive linguistics and psychology (conceptual metaphor theory and construal level theory of psychological distance, respectively) in using metaphors in pharmaceutical pollution risk communication. Our methods included a randomized cross-over design in which a convenience sample of university students (n = 20) viewed visual representations of pharmaceutical pollution risks (metaphor based and non-metaphor). We used cognitive interviewing methods to assess metaphor use on participants understanding of pharmaceutical pollution risk, concern about this risk, and willingness to act. Results indicate that participants preferred the metaphorically-framed visual, and that the use of metaphor significantly reduced participants’ perceived social and geographic distance of pharmaceutical pollution risk, suggesting a relationship between metaphoric framing and psychological distance warranting additional research. Theoretical and practical implications of metaphor use in risk communications are discussed.

Keywords Psychological distance · Metaphor · Pharmaceutical pollution · Risk communication · Cognitive interviewing · Environmental perception

Introduction
Pharmaceuticals are considered chemicals of emerging concern because of their ecotoxicological impacts on the environment and human health (Environmental Protection Agency 2008). As commercial chemicals, pharmaceuticals flow from consumers to the environment during their life cycle on a continual basis (Glassmeyer et al. 2009). Consumer behaviors, such as disposal of household medications (e.g., via the trash or down the drain), significantly contribute to the volume of pharmaceutical compounds found in water. For example, Dohle et al. (2013) found that many people believe flushing drugs down the drain or toilet is unlikely to have harmful environmental impacts, particularly when the drugs are familiar over-the-counter (OTC) medications like pain relievers. And yet, as the authors point out, common pain relievers are one of the most frequently detected classes of pharmaceutical chemicals in the
aquatic environment and can have severe adverse ecological impacts. Thus, understanding public perceptions of aquatic pharmaceutical pollution and developing effective risk communication techniques are critical to engaging society in the type of widespread change necessary for addressing the presence of pharmaceuticals in water. In this study, we apply psychological distance to characterize perceptions, attitudes, and behaviors toward aquatic pharmaceutical contamination and conceptual metaphor theory to assess the impact of metaphor use in risk communication on relevant perceptions, attitudes and behaviors.

**Pharmaceuticals in the Environment**

Nationally, a growing body of literature documents the presence of pharmaceutical compounds in ground water (Banzhaf et al. 2011), surface waters (Kolpin et al. 2002; Lara-Martín et al. 2014, 2015), and drinking water (Focazio et al. 2008; Padhye et al. 2014; Stackelberg et al. 2007). In addition, pharmaceutical compounds have been detected in multiple aquatic species (Brandao et al. 2014; Ramirez et al. 2009), including edible species (Antunes et al. 2013); and have been shown to cause reproductive and behavioral impacts in fish (Jobling et al. 2006), bivalves (Antunes et al. 2013), and zooplankton (Flaherty and Dodson 2005).

Consumers are a primary source of pharmaceuticals in the environment. Excretion, disposal, and bathing off topical medications are the main consumer routes by which pharmaceuticals enter the environment (Daughton 2007). As pharmaceutical use continues to rise, so does the volume of medications that may eventually enter the waste stream with one recent study reporting that up to 60% of household medications are unused or wasted (Chung et al. 2019). Common household drug disposal methods, such as via municipal trash or household drains, lead to drinking and surface water contamination through landfill leachate and wastewater effluent (Daughton 2007). To reduce this preventable source of aquatic pharmaceutical contamination, government agencies, hospitals, pharmacies, and not-for-profits are now offering drug collection (“take-back”) programs as an alternative disposal method.

Although Americans are increasingly aware of aquatic pharmaceutical pollution and its consequences, people continue to improperly store or dispose of medications (Bound et al. 2006) and many collection programs are not attracting significant participation. A study of university students indicated that in the last 12 months, a majority had purchased and used OTC (87%) and prescription drugs (77%) and had leftover medications of which they had not yet disposed (Vatovec et al. 2016). Of those who disposed of leftover drugs within the last year, only 1% with leftover OTC and <1% with leftover prescription medications did so through a drug take-back program.

Public awareness of and beliefs about environmental consequences of improper drug disposal may impact individual participation in take-back programs (Chung et al. 2019). For example, one recent study found that people who believe there is an environmental health threat from pharmaceutical pollution are more willing to pay for a local take-back program, regardless of past disposal behavior (Stoddard et al. 2017). Conversely, perceived uncertainty regarding the consequences of and solutions to aquatic pharmaceutical pollution may lead to inaction, presenting a barrier to participating in take-back programs.

A recent content analysis of the U.S. news media’s coverage of aquatic pharmaceutical pollution found three areas in which the U.S. news media may introduce uncertainty (Blair et al. 2017). First, coverage of aquatic pharmaceutical pollution in the U.S. news media is sparse and often describes impacts to human and environmental health as uncertain (especially the former), despite decades of scientific literature. Casting uncertainty on how an individual should participate and the efficacy of individual action, the main actors featured in the news media (water utilities, scientists, government actors, and pharmaceutical representatives) present different solutions (improved water treatment technology, take-back programs, and trash disposal, respectively). Finally, the study reported that 36% of articles described aquatic pharmaceutical pollution as unregulated, potentially confusing readers who believe the pharmaceutical industry is strictly regulated by the U.S. government.

Risk communication and take-back program outreach materials are an important and often overlooked opportunity to inform risk perception, raise awareness, and encourage participation in take-back programs. Research has shown that effectively targeting specific audiences through tailored content and placement of drug take-back program outreach and advertising materials may successfully attract a wide range of participants (Stoddard et al. 2017).

Promoting widespread participation in drug collection programs is a useful first step in addressing aquatic pharmaceutical pollution (Glassmeyer et al. 2009). These initiatives encourage individual action and consumer responsibility, critical foundations for systems-level change to significantly reduce the presence of pharmaceutical chemicals in water (Daughton 2003). This study characterizes public perceptions and theoretical relationships between psychological distance and metaphor use to inform effective risk communication techniques for drug collection programs.

**Theoretical Grounding and Approaches**

As cognitive frameworks, psychological distance, and conceptual metaphor theory share a foundation that people experience and represent stimuli either as concrete or abstract, which impacts attitudes and behaviors (Landau
Psychological distance, an index of how near or far a concept is from a perceiver’s immediate experience, suggests a psychologically distant concept is represented through its abstract qualities (e.g., decontextualized features) and a psychologically close concept is construed in concrete terms (e.g., specific, perceptual details). Relevant attitudes and behavior are positively associated with psychological distance, and different distances (near or far) lead to different attitudes and behaviors. Conceptual metaphor theory suggests that people use metaphor as a cognitive tool to understand abstract concepts through more concrete terms (e.g., “life is a journey”). As a psychological tool (Hatano and Wertsch 2001), metaphor use impacts people’s practical judgments of a target concept based on understood features of the source concept.

This observation has inspired a small but growing body of research that explores the theoretical and practical interactions between the two frameworks. However, studies have so far only investigated whether manipulating conditions of psychological distance impacts conceptual metaphor use. For example, research has shown that people are more likely to rely on metaphor when concepts are framed as psychologically distant (and abstract) versus near (and concrete) (Jia and Smith 2013). No one has yet examined whether metaphor use impacts perceived psychological distance, or relevant cognitive judgments such as attitudes and behavioral intentions.

This study addresses these gaps in the theoretical literature while also addressing the need to better understand public perceptions of aquatic pharmaceutical contamination. The objectives of this pilot study are (1) to assess the impact of metaphoric framing on perceived distance of the environmental hazard across dimensions (temporal, geographic, social group, and uncertainty), (2) to assess the impact of metaphoric framing on concern for the environmental hazard across dimensions, and (3) to assess the impact of metaphoric framing on willingness to act (Fig. 1). This research contributes to the theoretical advancement of psychological distance and metaphor theories and informs practical risk communication strategies encouraging participation in drug take-back initiatives.

**Construal Level Theory and Psychological Distance**

Construal level theory (Liberman and Förster 2009; Trope and Liberman 2010) posits that people perceive events, objects, actions, and other stimuli either as low-level (understood in specific terms) or high-level (conceptualized through global terms) constructs, which are inextricably linked to psychological distance. Within construal level theory, psychological distance is the mental distance perceived between a stimulus and the perceiver’s direct experience of their self in the present moment (Bar-Anan et al. 2007). Psychologically close stimuli tend to be low-level construals, understood through sensory and/or concrete terms (Bar-Anan et al. 2007). Psychologically distant stimuli are generally high-level construals understood through abstract, global terms (Liberman and Förster 2009).

Psychological distance is frequently studied through four primary dimensions: uncertainty, social group, geography, and time. An event is psychologically closer when it is more likely to occur (uncertainty), happens to people like oneself (social group), occurs nearby (geographic), and takes place in the present or near future/past (time) (Milfont et al. 2011). Psychologically distant events are perceived as unlikely to occur, happening to people unlike oneself, occurring far away and taking place in the distant future/past. Experimental evidence suggests that the dimensions are positively associated, so thinking about one dimension in psychologically close or distant terms may impact the cognitive processing of other dimensions (e.g., thinking about people unlike oneself may prime one to perceive a greater geographic distance) (Bar-Anan et al. 2007). Jones et al. (2016) found that when measuring psychological distance as a multidimensional construct there was some variance in perceived distance between dimensions and suggested this may be due to relevant sociocultural and historical contexts, such as recent extreme weather events.

Psychological distance and construal level theory have wide-ranging implications for understanding and motivating human thought and behavior. Research has shown that when a concept is perceived as psychologically distant, people make choices based on their values (i.e., kindness); when something is represented as psychologically close, specific, contextual details like feasibility concerns (e.g., expected time commitment) and anticipated outcomes guide decisions (Trope and Liberman 2010). In addition, the
Conceptual Metaphor Theory

Conceptual metaphor theory states that people rely on metaphors as a cognitive tool to make sense of abstract concepts through more concrete terms (Gibbs 1996; Lakoff and Johnson 1980). Metaphors in this context are conventional, everyday metaphors used by regular people (Morris et al. 2007). According to Geary (2011), English speakers typically use about one metaphor for every 10–25 words spoken, or about six metaphors per minute (Landau et al. 2014).

In the metaphor framing model, metaphoric description (“using terms from another domain to talk about an event”) primes metaphoric encoding (“using schemas from another domain to think about an event”) (Morris et al. 2007). This results in the perceiver transferring knowledge of a source concept to interpret a target concept (Jia and Smith 2013). Typically, source concepts are more easily comprehended and concrete experiences, whereas target concepts tend to be complex, hard to understand and more abstract (Landau et al. 2014). For example, past research demonstrates that metaphorically evoking the experience of protecting one’s body from contamination impacts people’s judgments about their country’s immigration policy. In two different studies, Americans more frequently opposed open immigration policies after being motivated to protect their own bodies from harmful (versus neutral) fictional bacteria (Jia and Smith 2013; Landau et al. 2009).

Exposure to different metaphors produces different effects on a person’s practical judgments. For example, investigating the consequences of stock market commentators’ use of metaphors on the judgments of investors, Morris et al. (2007) found that exposing participants to agent-metaphors that implied an “enduring internal disposition” reflected through observed price trends (e.g., “The Nasdaq climbed higher”) resulted in an increased expectation that a present price trend would persist the next day. In contrast, neither object-metaphors, which do not imply an internal motivation (i.e., “The Nasdaq was pushed higher”), nor non-metaphorical descriptions of the stock market impacted investors’ expectations of trend continuance.

Important, certain conditions are necessary in order for a metaphor to be activated and made useful as a conceptual tool. For example, a metaphor needs to be culturally and contextually relevant (Landau et al. 2010). It also needs to be accessible to the individual perceiver and aligned with their unique epistemological and ontological perspectives. Steen et al. (2014) suggest that reinforcing the metaphor through additional supportive textual/contextual references increases metaphoric transfer. Recent research also indicates that certain conditions of psychological distance may also be required for metaphoric activation (Jia and Smith 2013).

Methods

In this pilot study, we applied a mixed-methods approach to characterize perceptions of psychological distance, concern and behavioral intentions towards aquatic pharmaceutical contamination and whether metaphor use in risk communications impacts these perceptions. The study was approved by the University of Vermont (UVM) Institutional Review Board.

Data collection took place in Burlington, Vermont, between September 20 and November 7, 2016. All currently enrolled students (over the age of 18) able to meet in person on the UVM campus were eligible. The tailored design method (Dillman 2014) was applied to all phases of the study. Volunteer participants were recruited through email announcements sent through student listservs. Confidential, individual in-person interviews were audio-recorded and lasted 55 min on average.

Sampling Procedure

To understand whether metaphor use impacts perceptions of psychological distance, concern, and behavioral intentions, the study was designed as a crossover study to reduce potential order and performance variation effects (e.g., practice, boredom, fatigue, etc.). Participants were randomly assigned a treatment sequence group (group A or group B), counterbalancing the order of metaphor and non-metaphor treatments. Each treatment group was composed of half of the total sample ($n = 10$; see Table 1).
Data were collected using cognitive interviewing (Beatty and Willis 2007; Willis 2004), a semi-structured, interactive, and in-depth qualitative survey method (de Leeuw et al. 2008), in which participants respond to a survey questionnaire while discussing aloud their thought processes and answer selections. Cognitive interviewing seeks to understand how respondents understand questions and the cognitive processes that are used to produce an answer (Beatty and Willis 2007) and requires a small but deliberate sample (typically 15–40 participants).

Participants were instructed to read each survey question aloud, select an answer, and discuss their thought processes with the interviewer through one of the six general but directed types of cognitive interviewing prompts outlined in Groves et al. (2011).

Between- and within-group results were compared using descriptive statistical analysis and qualitative analysis. A Wilcoxon signed ranks test (assuming a null hypothesis of no change in mean response between pairs) was used to assess whether any within-group changes after the first and second visual treatments were statistically significant at $p < 0.10$. The decision to use a 10% significance was based on the small sample size and pilot-nature of this mixed-methods study.

It should be noted that following first treatment and subsequent repetition of the survey, most participants ascertained that we wanted to know if the visual changed how they thought about the issue. Consequently, the crossover study design did not successfully prevent order effects and people became practiced in the survey after the first treatment. As a result, the second treatment had an insignificant and unclear impact on both groups and only baseline and first treatment results are reported here.

### Results and Discussion

Based on the Fall 2016 UVM Enrollment Report, the sample was roughly representative of the overall UVM student population in key demographic characteristics including gender, race, student level (undergraduate versus graduate), and in-state versus out-of-state residence (University of Vermont 2016). Survey respondents were 45% male and 50% female (5% of respondents did not select a sex). A majority of participants (85%) presently resided in Burlington, Vermont, identified their race as White/Caucasian (80%) and ethnicity as not Hispanic or Latino/a (100%), were undergraduate-level students (90%), and were out-of-state residents (65%). The sample was not representative of the UVM student population in

### Materials

#### Survey instrument

The survey questionnaire was composed of (1) baseline perceptions of and behavioral intentions toward aquatic pharmaceutical contamination, (2) perceptions and behavioral intentions after viewing the first of two poster advertisements for safe drug disposal, (3) perceptions and behavioral intentions after viewing second poster advertisement for safe drug disposal, and (4) demographics (see Supplementary Materials for the full survey instrument). Survey questions assessed perceptions of distance and levels of concern across the four primary dimensions of distance (geographic, social group, uncertainty, and temporal) and were adapted from Spence et al. (2012).

#### Visual treatments

Two fictional posters were developed as potential advertisements for drug collection programs, one framing the issue through a “nature as body” metaphor, and one without this metaphor. The posters were identical in design and visual organization but differed in content (see Supplementary Materials for both visual treatments). The metaphor poster employed the root metaphor of “nature as body” to prime participants to protect their own bodies from contamination. Jackson (1983) demonstrates that personal and nature “bodies” are metaphorically linked in many cultural and religious traditions.

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**Table 1** Procedure

| Interview survey treatment order | Treatment group |
|----------------------------------|-----------------|
| A ($n = 10$)                     |                 |
| B ($n = 10$)                     |                 |
| 1. Consent & 2. Instructions ✓✓|                 |
| 3. Questions on awareness of topic ✓✓|               |
| 4. Psychological distance survey ✓✓|               |
| 5. 1st visual Metaphor treatment | Non-metaphor treatment |
| 6. Psychological distance survey ✓✓|               |
| 7. 2nd visual Non-metaphor treatment Metaphor treatment |
| 8. Psychological distance survey ✓✓|               |
| 9. Questions on current behavior ✓✓|               |
| 10. New ecological paradigm scale (Dunlap et al. 2000) ✓✓|               |
| 11. Demographic information ✓✓|               |
undergraduate degree year or UVM school/college affiliation (see Supplementary Materials for full demographics).

This pilot study resulted in three primary findings. First, participants initially reported perceiving the issue of pharmaceutical pollution as distant across social and geographic dimensions, while perceiving the issue as comparable at near and far distances when considering the dimensions of time and uncertainty. Second, representing pharmaceutical pollution through the nature-as-body metaphor significantly reduced perceived social and geographic distance, as compared with the non-metaphor-based representation, but did not significantly impact perceived distance across temporal or uncertainty dimensions. Finally, the metaphor-based treatment did not significantly impact concern or behavioral intentions.

**Initial Perceptions of Pharmaceutical Pollution: Psychological Distance, Concern, and Willingness to Act Across Dimensions**

Participants of treatment groups A and B more strongly agreed that pharmaceutical pollution is a distant geographic and social issue (versus near), and expressed higher levels of concern for the issue at greater geographic and social distances (Table 2). However, in response to questions of concern for the issue at greater geographic and social issue (versus near), and expressed higher levels of concern for the issue at greater geographic and social distances (Table 2). However, in response to questions regarding temporal distance and uncertainty, participants expressed nearly equal agreement that pharmaceutical pollution is a near and far issue. Consistent with past research (Jones et al. 2016), our results indicate people perceive psychological distance as a multidimensional construct and perceptions of distance vary somewhat depending on the dimension of distance being considered.

The perception that the issue is more likely to impact other places and people may be due to spatial bias (environmental problems are believed to be worse at global versus local levels (Uzzell 2000), especially by younger and happier people (Schultz et al. 2014)) and/or spatial optimism (environmental conditions are better here than elsewhere) (Gifford et al. 2009; Milfont et al. 2011). For example, in a study assessing California farmers’ perceptions of climate change policy risks, Niles et al. (2013) found that overall farmers believe climate change poses greater risks to agriculture globally (far) than to agriculture in Yolo County, California (near). Milfont et al. (2011) hypothesized that New Zealanders’ ingrained belief of their country as “clean and green” may lend itself to spatial optimism. Similarly, a spatial optimism bias in the current study may be explained by the popular image of Vermont (particularly Burlington, VT) as progressive and environmentally conscious, as compared with other places.

These cognitive biases have implications for behavior. Believing environmental problems to be more severe at a global level can lead to decreased feelings of self-efficacy (feeling able to do something about the problem) and responsibility for the problem (Uzzell 2000), which in turn discourages individual action. Likewise, our baseline results indicate people felt more motivated (a value-driven, high-level construal) than prepared (a low-level construal motivated by feasibility concerns) to participate in pharmaceutical take-back initiatives, which may be connected to perceptions that aquatic pharmaceutical contamination is a distant issue.

**The Impacts of Metaphor-Based Framing on Perceptions of Pharmaceutical Pollution**

Qualitative data capturing people’s responses to the metaphor-framed visual indicate the metaphor successfully provoked people to think about bodily exposure while interpreting the issue of aquatic pharmaceutical contamination. Further, the majority of respondents preferred the metaphor-based visual to communicate about drug take-back programs.

All participants were asked to describe their experience of each visual treatment, allowing us to assess the impact of the metaphor. Comparing the two potential advertisements, a majority of respondents (55%) stated a preference for the metaphor visual, 15% preferred the non-metaphor visual, and 30% could not be determined. While viewing the metaphor treatment, most people (55%) described thinking about exposure to their bodies and linking that to thinking about pharmaceuticals in the water.

““Asking the question, ‘what’s in your body of water?’ makes you really wonder what’s in your body of water, like what’s going into your body? And then obviously having these pills in front of the lake makes you wonder again. […] so, you’re like ‘oh drugs in my body! That’s not a good thing!'” (Participant T).

““What’s in your body of water? […] if you ask this I would probably think what is the mechanism of the medication – what is this medication going to cause in your body – what’s in your body of water…” (Participant A).

Comparatively, while viewing the non-metaphor treatment, nearly everyone described their reaction to seeing the types and/or quantity of drugs represented. Various reactions included shock, disinterest, and familiarity, among others. People also often commented on the headline question, “Got Drugs?”, which is used in advertisements for
The U.S. Drug Enforcement Agency’s biannual National Take-Back Day. Many remarked that in a college environment, this may not be as attention-grabbing as it could be in other community settings.

Impact of metaphor use on psychological distance

Metaphor use significantly reduced the perceived psychological distance of pharmaceutical pollution, compared with the non-metaphor intervention and baseline results. After viewing the metaphor-based visual, treatment group A participants perceived aquatic pharmaceutical contamination as significantly geographically \((p = 0.083)\) and socially \((p = 0.034)\) closer than was indicated by their baseline responses. Comparatively, treatment group B, who viewed the non-metaphor treatment, had no significant changes in perceived psychological distance (Fig. 2).

Given the function of metaphor use (describing abstract concepts through concrete terms), we would expect metaphor-based framing to have a greater impact when conditions of psychological distance are present. In this study, initial responses indicated pharmaceutical pollution

| Table 2 Initial perceptions of psychological distance, concern, and willingness to act across dimensions for treatment groups A and B \((n = 20)\) |
|---|---|---|---|---|---|
| Construct | Dimension distance | Question | Response options | Initial mean response | % unsure |
| Distance | Geographic near | My local area is likely to be affected by the presence of pharmaceuticals in the water. | 4-point scale (4) Strongly Agree – (1) Strongly Disagree | 3.3 | 0 |
| | Geographic far | The presence of pharmaceuticals in the water will mostly affect areas that are far away from here. | 3.1 | 5 |
| | Social near | People like me are likely to be affected by the presence of pharmaceuticals in the water. | 3.2 | 10 |
| | Social far | Other people who are not like me are likely to be affected by the presence of pharmaceuticals in the water. | 3.5 | 5 |
| | Uncertainty presence | Scientists are uncertain about the presence of pharmaceuticals in the water. | 1.7 | 10 |
| | Uncertainty causes | Scientists are uncertain about what causes the presence of pharmaceuticals in the water. | 1.8 | 0 |
| | Uncertainty problem | I am uncertain that the presence of pharmaceuticals in the water is really an issue. | 1.8 | 0 |
| | Time near people | Do you think local residents will feel the effects of pharmaceuticals in the water? | 4-point scale (4) Yes, already feeling the effects – (1) No, I don’t think the effects will be felt | 3.3 | 30 |
| | Time far people | Do you think people in other areas around the world will feel the effects from the presence of pharmaceuticals in the water? | 3.3 | 20 |
| | Time near environment | Do you think the local aquatic environment will feel the effects from the presence of pharmaceuticals in the water? | 4.0 | 10 |
| | Time far environment | Do you think aquatic environments in other places around the world will feel the effects from the presence of pharmaceuticals in the water? | 3.8 | 5 |
| Concern | Geographic near | When I think about my local area, I am concerned about the presence of pharmaceuticals in the water. | 4-point scale (4) Strongly agree – (1) Strongly disagree | 3.4 | 15 |
| | Geographic far | When I think about areas around the world, I am concerned about the presence of pharmaceuticals in the water. | 3.7 | 0 |
| | Social near | When I think about people like me, I am concerned about the presence of pharmaceuticals in the water. | 3.2 | 5 |
| | Social far | When I think about other people who are different from me, I am concerned about the presence of pharmaceuticals in the water. | 3.5 | 5 |
| | Uncertainty environment | It is uncertain if the presence of pharmaceuticals in the water will have any effects on the environment. | 1.4 | 5 |
| | Uncertainty people | It is uncertain if the presence of pharmaceuticals in the water will have any effects on people. | 1.8 | 5 |
| | Time near | When I think about the near future, I am concerned about the presence of pharmaceuticals in the water. | 3.4 | 10 |
| | Time far | When I think about the distant future, I am concerned about the presence of pharmaceuticals in the water. | 3.4 | 10 |
| Behavioral intentions | Prepared | I feel prepared to participate in a pharmaceutical take back initiative. | 4-point scale (4) Strongly Agree — (1) Strongly Disagree | 3.4 | 5 |
| | Motivated | I feel motivated to participate in a pharmaceutical take back initiative. | 3.6 | 10 |
...was only perceived as psychologically distant across geographic and social dimensions. Consistent with this expectation, metaphor use did not significantly alter perceived temporal distance or uncertainty as compared with baseline perceptions (Table 3).

**Impact of metaphor use on concern and willingness to act**

Representing the issue through metaphor had no direct, statistically significant effect on treatment group A’s initial levels of concern across dimensions, although overall concern increased across dimensions and distances. The non-metaphor treatment significantly increased treatment group B’s concern for geographically distant impacts ($p = 0.083$), compared with their baseline responses. In general, this treatment also increased concern across dimensions and distances, although no other change was statistically significant.

Metaphor use also had no direct, statistically significant impact on group A’s behavioral intentions (Fig. 3), although people felt equally prepared and motivated to participate in a drug collection program (versus initially being more motivated than prepared). The non-metaphor visual also had no significant effect on group B’s behavioral intentions. People continued to feel more motivated than prepared.

Recent research suggests psychological distance mediates the impact of message frame manipulations, like metaphoric framing, on concern and behavioral intentions. Jones et al. (2016) found that framing messages to manipulate (reduce) psychological distance indirectly increased concern and willingness to act, but had no direct, statistically significant effect on either construct. Due to our small sample size, we could not assess whether psychological distance mediated the impact of metaphor use on concern and willingness to act; however, we strongly recommend that future research consider this particular relationship using the survey materials piloted and refined in the current study and following the methodology of Jones et al. (2016).

According to Rabinovich et al. (2009), reducing psychological distance may be especially critical when specific individual actions are needed to achieve a relatively abstract goal, like participating in a drug collection program to reduce aquatic pharmaceutical contamination, which cannot be detected through the senses. Therefore, risk communication efforts to bring this issue closer may indirectly lead to greater concern and preparedness to act at an individual level.

**Methodological Contributions and Limitations**

In this study, cognitive interviewing was used to understand how people perceive the issue of aquatic pharmaceutical contamination using questions adapted from Spence et al. (2012) to measure psychological distance, concern and willingness to act. In the process of interviewing, we found key constructs were interpreted differently from person to person. For example, some people interpreted the geographic near construct, “my local area”, as the immediate area around Burlington, Vermont, while others assumed it meant their hometown located in another county, state or country. People often interpreted “near future” and “far future” as the future in general. In addition, people commonly considered social factors when responding to questions assessing geographic distance and concern (e.g., regulations, environmental values, income, etc.) and likewise geographic features when answering questions assessing social distance and concern (e.g., proximity to water, physical location, etc.). These multiple interpretations could lead to inconsistent responses. As psychological distance becomes an increasingly popular framework for measuring perceptions, attitudes and behaviors, there is a need for standardized, validated language framing each dimension of distance that can be applied to studies across disciplines and topic areas.
We want to note that among this particular sample population it is possible that perceived psychological distance and concern for aquatic pharmaceutical contamination were impacted by (1) the proximity and visibility of Lake Champlain within Burlington, Vermont, (Milfont et al. 2014), (2) prior awareness (Milfont 2012), (3) socially

**Table 3** Statistical results using Wilcoxon signed ranks test, a nonparametric method for analyzing differences and magnitude of difference between paired data that assumes a null hypothesis of zero difference (McDonald 2014; Whitley and Ball 2002)

| Construct | Variable | Metaphor treatment (N = 10) | Non-metaphor treatment (N = 10) |
|-----------|----------|-----------------------------|----------------------------------|
|           |          | Z score | p value* | Z score | p value* |
| Distance  | Geographic near | -2.121 | 0.034 | 0.000 | 1.000 |
|           | Geographic far | -1.633 | 0.102 | -0.816 | 0.414 |
|           | Social near | -1.732 | **0.083** | -1.000 | 0.317 |
|           | Social far | -0.577 | 0.564 | -0.447 | 0.655 |
|           | Uncertainty presence | -1.342 | 0.180 | -1.000 | 0.317 |
|           | Uncertainty causes | -1.000 | 0.317 | -1.342 | 0.180 |
|           | Uncertainty problem | -0.816 | 0.414 | -1.633 | 0.102 |
|           | Time near people | -1.000 | 0.317 | -1.414 | 0.157 |
|           | Time far people | -1.342 | 0.180 | -0.577 | 0.564 |
|           | Time near environment | 0.000 | 1.000 | 0.000 | 1.000 |
|           | Time far environment | -1.000 | 0.317 | 0.000 | 1.000 |
| Concern   | Geographic near | -1.000 | 0.317 | -0.816 | 0.414 |
|           | Geographic far | 0.000 | 1.000 | -1.732 | **0.083** |
|           | Social near | -1.000 | 0.317 | -1.000 | 0.317 |
|           | Social far | -1.342 | 0.180 | 0.000 | 1.000 |
|           | Uncertainty environment | -1.342 | 0.180 | -0.577 | 0.564 |
|           | Uncertainty people | -1.633 | 0.102 | -1.134 | 0.257 |
|           | Time near | -0.816 | 0.414 | -0.577 | 0.564 |
|           | Time far | -1.342 | 0.180 | -0.577 | 0.564 |
| Willingness to act | Prepared | -1.000 | 0.317 | 0.000 | 1.000 |
|           | Motivated | -1.000 | 0.317 | -0.577 | 0.564 |

*Statistically significant values (p < 0.10) are bolded for emphasis

aBased on negative ranks

bBased on positive ranks

cThe sum of negative ranks equals the sum of positive ranks

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desirable responding (the tendency of questionnaire respondents to self-report socially acceptable answers) (Van de Mortel 2008), and (4) the use of visual (versus text) communications, which may suggest proximity between a communicator and audience (Amit et al. 2013). In addition, we know from qualitative data that answering questions about the topic in the context of a research study reduced perceived uncertainty about the issue and impacted people’s concerns for the near and far future. For example, some people felt less concerned about the far future because they assume that current studies, such as the one they were participating in, will lead to future solutions.

**Conclusion**

Consumer attitudes and behaviors significantly contribute to the presence of pharmaceutical chemicals in water systems with consequences to human and environmental health. In this study, we found that aquatic pharmaceutical contamination was initially perceived as geographically and socially distant. Further, compared with baseline perceptions and the non-metaphor treatment, using a nature-as-body metaphor to frame the issue of aquatic pharmaceutical contamination significantly reduced the perceived psychological distance of the issue, specifically across geographic and social dimensions of distance. While metaphor-based framing did not significantly impact participants’ concern or behavioral intentions, past research suggests that reducing perceived distance through a framing manipulation, like metaphor, may indirectly positively influence concern and preparedness to act. Finally, we found people interpret distances (near/far) and dimensions (geographic, social, temporal, and uncertainty) in different ways, suggesting the need for validated questions to consistently measure psychological distance.

While other studies have explored how framing psychological distance affects metaphor use, this study is the first that we know of to assess how metaphor use impacts perceived psychological distance. Our findings contribute to a growing body of theoretical literature exploring the utility of psychological distance and conceptual metaphor theory in understanding how people process and form cognitive judgments on everyday stimuli. In addition, results from this study have practical applications for designing risk communications that effectively promote public awareness and individual action on the issue of aquatic pharmaceutical contamination.

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**Compliance with Ethical Standards**

**Conflicts of Interest** The authors declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Vermont Institutional Review Board (14-612) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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